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ABSTRACT

Two volumes designed to increase awareness of accidental nuclear war dangers are presented. The first of 5 sections in volume I proposes that although accidental war is preventable, the current arms race and secrecy about accidents and false alarms increase the possibility of an accidental war. Section 2 posits that decreased decision-making time also increases the possibility of error. Section 3 deals with information-related accidents such as strategic warning system problems, lengthy command chains, and communication chaos due to electromagnetic pulse. Section 4 gives examples of accidents and illnesses that affect the capabilities of national leaders, problems of weapon handlers, proliferation perils, implications of escalating small wars, and ways in which terrorists could trigger nuclear war. Section 5 focuses on accidents involving new weapons. Section 6 (in volume II) examines both the value of and the dangers of satellite usage. Section 7 discusses the probability of an accidental nuclear war and the final section outlines prevention needs, including increased public awareness, improved hot lines, better crisis control communication between nations, accidental war assessment centers, long term goals for world peace, and action taking. Appendices outline problems of U.S. strategic warning systems, nations technically capable of detonating a nuclear device, the balance of nuclear forces, and possible areas for error in weapon technology. A glossary concludes the document. (LH)

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DEDICATION

To a peaceful future for children

and grandchildren everywhere,

including our own.

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ACCIDENTAL NUCLEAR WAR: THE GROWING PERIL

A Handbook For Assessing Danger

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The ownership of the copyright on Chapter VI of this Review is hereby assigned to David C. Morrison with no restrictions or limitations aside from his permission to publish Chapter VI as part of this Review.

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This review could never have been written without the help of many people. Any effort to reduce a large and complex subject into a small and readily understandable review takes considerable time and assistance of many people. We deeply appreciate everyone who aided us. Some deserve special mention because of unique or extensive help.

A year ago, when we were writing articles to increase the awareness of accidental war dangers, Dr. Alan Newcombe, the editor, suggested we write a book on the subject. He continuously provided valuable information and suggestions.

Wyone Babst repeatedly helped edit and type the many drafts it took to complete the review. Elaine Apthrop, Ph.D. candidate at the University of California, Berkeley, reviewed the entire book for clarity and construction.

Because some of our inquiries went unanswered we particularly appreciated the responses of the U.S. Senators, Congressmen and officials who responded specifically to the issues raised and provided useful materials. Nearly all expressed a concern about accidental war dangers. Their information is cited in the text.

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Ernest F. Hollings, S. Carolina

U.S. Congressmen

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PREFACE: NOTE TO SCIENTISTS

This review was written with the belief that accidental war has been inadequately researched. There are many reasons. First, most researchers and strategists prefer quantifiable/reproducible sets of data which can be easily modelled. But accidental phenomena do not readily lend themselves to such easy analysis. Secondly, a serious study of the unintentional war scenario must go beyond psychology, strategy, and politics. It must integrate as well the physiology of human reaction to situations of enormous stress (such as in crisis) which will increasingly occur as conflicts over limited resources are exacerbated. In addition, we must integrate the physics and engineering of complicated mechanical and electronic systems such as computers and satellites on which our strategic warning systems depend. Perhaps more importantly, we need to study the man-machine interactions. Increasingly, the technology is outstripping man's capacity to really understand all that is happening in a war-control-room.

In the above respect this study is wholly inadequate, as we are able to touch on only a few of these issues. In all that we have written, we have consulted thousands of books, journals and technical documents, as well as many defense research organizations and military officials. Some of our questions were never answered to our satisfaction, and we have come to believe that many of the top officials do not have a global view of the peril. That must change lest our policies be inadequate to deal with crises which surely will occur, sooner or later. Synthesis must soon be created out of the enormous specialization that has allowed the accidental war possibility to remain unexplored to a large extent.

Before we start, allow us to sketch the accelerating arms spiral the world finds itself in as excerpted from the 1983 yearbook *World Armaments and Disarmament*.*

* These quotations are from Frank Blackaby's Introduction (especially page XXXVII & following) to the *SIPRI Yearbook 1983 (World Armaments and Disarmament)*.

"The rise in world military expenditure is accelerating - a warning sign." The Stockholm International Peace Research Institute estimates that global military spending in 1982 reached at least $700 billion. "The volume over the past four years shows a rate of increase of nearly 4 per cent a year, compared with just over 2 per cent a year in the previous four-year period." (p. XXXVII)

"In recent years military expenditure has been increasing by more than 4 per cent a year in the Middle East, South Asia, the Far East (excluding China), Oceania, and Latin America." (p. XXXVII)

"In France the nuclear deterrent is a major budget priority, accounting for 14 per cent of the defense budget in 1982. A particularly rapid increase in expenditure on tactical nuclear weapons is planned this year." (p. XXXIX)

"In Japan a climate more favorable to military spending has developed. The five-year defense plan announced in July, 1982, calls for annual increases of military expenditure in real terms of 6.3 to 8 per cent." (p. XXXIX)

"In Latin America, the Falklands war spurred a new cycle of the arms race in Argentina and its neighbors." (p. XLIV)

"The proliferation of major conventional weapons throughout the world continues. The total volume of weapons transfers was about 80 per cent greater from 1978 through 1982 than in the previous five-year period. The U.S. and the Soviet Union each account for about one third of total arms exports." (p. XL)

"The superpowers also are accelerating the militarization of outer space. The U.S. military space budget increased this year by some 20 per cent in real terms over previous years. The Soviet Union conducted an anti-satellite test in June, 1982, reportedly coordinated with the test launch of two intercontinental ballistic missiles and two anti-ballistic missile tests. Three quarters of all satellites launched have been military satellites." (p. XLII)

Meanwhile, basic research is proceeding at an awesome pace, with military applications galore.

In this period of growing danger, the authors wish to be a positive influence. In order to motivate people for prevention efforts, we have striven to be as forceful as accuracy permits. We urge you to argue with us where we have overstated or understated the danger. Any relevant materials or ideas you care to call to our attention will be appreciated. We wish to work together with those striving to prevent the peril of an accidental nuclear war.

SUMMARY

ACCIDENTAL NUCLEAR WAR: THE GROWING PERIL

Unless the current direction of the arms race is changed, an accidental (unintentional) nuclear war is a certainty. It is only a matter of time. We challenge anyone to prove differently for the reasons given in this Summary.

HOPE

No nation alone can stop the arms race. Alerting other nations to the growing danger of an accidental war could greatly increase the desire of all nations for arms control and prevention measures. Most people are only vaguely aware of the possibility of an accidental war. A nuclear war can be prevented, if we can convince all nations that they need to be far more fearful of an accidental war than each other. In this sense a dreadful fear can be converted into an exciting hope by providing a powerful motive for global arms reduction.

REASONS

The possibility of an accidental nuclear war is growing for the following reasons:

Decreasing Time For Decision Making

The opportunity for a war to start by misjudgement or miscalculation or false alarm is greatly increasing. The time available to the U.S. or the U.S.S.R. for deciding whether or not to launch a nuclear attack has decreased from 12 hours in the 1950s to less than 8 minutes today. This is all the time available for identifying and confirming whether an object is a missile or not. It then takes time to find and notify a nation's leaders for a missile launching conference. Once found they must decide if the supposed attack is one missile or the cutting edge of a massive preemptive strike. This decision may have to be made in 2 minutes or less once the leaders are notified.

Sneak Attack Weapons

Even this minute time for decision making will become increasingly uncertain as the number of weapons systems being designed to attack without warning grows. Cruise missiles and stealth bombers are being designed to evade radar and strike with no warning. As the number of nations with sneak weapons increases, the possibility of a nation launching missiles to a false alarm or misjudged threat grows.

The U.S. plans to spend more than $100 billion for cruise missiles, B-1B bombers and Advanced Technology Bombers (ATB). The U.S. alone plans to build more than 9,000 cruise missiles, more than 5,000 being nuclear. Other countries are building similar weapons. As far as is known, nothing has been spent anyplace on assessing how much such weapons increase the possibility of an accidental war.

False Warnings

It is almost a certainty that all nations with strategic warning systems have false alarms. During one 18-month period the U.S. had 147 false alarms, with one lasting a full six minutes. The false alarm experience of other nations is now known, although the Korean Airliner tragedy demonstrated that the U.S.S.R. also has problems. This raises the question, could the first false alarm, that triggers any nation to launch missiles, ignite a global missile exchange?

Many Congressional and General Accounting Office reports are concerned about the U.S. warning system problems. For example, one Congressional Committee chaired by Jack Brooks* says, "The severe and potentially catastrophic deficiencies found in the Nation's missile attack warning system are a result of significant and long-term management failings within the Air Force and Joint Chiefs of

* NORAD Computer Systems are Dangerously Obsolete, Committee on Government Operation, U.S. Government Printing Office, Washington, D.C. March 1982.

Staff." Yet the Department of Defense's *"Fact Sheet"*** as well as letters to the authors describe our warning system as very good. How is such a vast disparity in presentation explained? Could we have a false sense of security?

Arms Build-Up Increase First Strike Nervousness

Apprehensions of a first strike multiply as an opponent's weapons systems grow increasingly accurate and powerful. Consequently opponents grow increasingly fearful, distrustful, hostile and crisis prone. Due to growing weapons complexity and secrecy, it is difficult for nations to determine the strength of their opponents. A nation may strike first, merely because they think an opponent is gaining an obliterating superiority.

As warning time decreases, the time allowed for deciding who should seize the first strike advantage in a growing crisis may be only minutes. How many crises will occur before some leader panics and goes nuclear?

Growing Number Of Nations With Nuclear Weapons

As the number of nations with nuclear weapons grows, the possibility of nuclear war increases. Nations could become more nervous or trigger happy for the following reasons:

- It takes fewer weapons to destroy a small nation so they may respond more quickly in a crisis to a false alarm or supposed threat.
- The nearer nations are to each other the less warning time they have for assessing accuracy of a threat or false alert.
- A local nuclear war may go global. A nuclear war anyplace on earth could create communication chaos (e.g. electromagnetic pulse blackouts) over a large area. The ensuing confusion

** Letter dated 6/30/83 and fact sheet from D.W. Kindchi, Chief, Media Relation Division, NORAD, Peterson Air Force Base, Colorado, to Center for Defense Information.

could cause other nations to believe they are under attack escalating the war.

Additional Dangers

The above describes only a few of the ways an accidental nuclear war could start. Fifteen ways (scenarios) that could trigger an accidental war are described in the review. Some examples of other dangers described are:

- How the arms race in space increases chance of an accidental war.
- How the growing complexity and workload of nations' strategic warning systems may be making their tasks impossible.
- How accidents and illnesses of national leaders can increase danger.
- How international terrorists could trigger a nuclear war.
- How weapons unreliability and accidents increase peril.
- How biological and chemical weapons can accelerate nations' nervousness.

Our tendency to look in an isolated manner at each of the ways an accidental war could start may be causing us to greatly underestimate the extent or immediacy of the danger.

Accidental War Far Greater Danger Than Premeditated War

The danger of an accidental war is growing while the danger of an intentional war is decreasing as the realization grows that a deliberate attack could be self destructive. A growing number of scientists agree that the climatic, biological and environmental changes due to a nuclear war between superpowers could be suicidal even if only one nation fired its weapons. The firing of many nuclear weapons could create a long global "nuclear winter" of darkness and cold so intense no crop or human could survive. Under such conditions who would deliberately start a nuclear war?

Prevention Needs

There needs to be a far greater sense of urgency to obtain arms reduction and war containment agreements. If a nuclear war occurs some place on earth the world is little prepared to keep it from going global. Nor is the world prepared to keeping a small nuclear war from contaminating the earth with radioactivity or making the earth colder if not creating a "nuclear winter."

The U.S. and Soviet Union are discussing ways to improve the "Hot Line" in order to reduce the risk of an accidental war. Until it is implemented, however, it means the U.S. and U.S.S.R.:

- Will not be able to use a high speed satellite network,
- Will not have high-speed facsimile transmission capability of sending maps.
- Will not have a secure voice and video capability.
- Will not have a direct bilateral Military Communications Link.
- Will not have high-speed links from their respective capitols to their embassies in crisis nations.
- Will not have a bilateral, face-to-face crisis control center.

The above shows how terribly unprepared the two superpowers are if a crisis erupts. We remain dependent upon a slow printed message system that is 20 years old. Crisis communication "Hot Lines" should be developed between many more nations than just the U.S. and U.S.S.R.

Multinational crisis control centers have been proposed by U.S. Senators for preventing terrorists or revolutionaries from triggering a global war. The U.S.S.R. and U.S. are discussing such centers but no agreements have been reached yet.

Nations need to be assessing each major planned change in weapons systems or policy to determine if it increases or decreases

the danger of an accidental war. Suggestions for establishing Accidental War Assessment Centers are described in the review. Does it make sense to be spending hundreds of billions of dollars annually for defense and to know little about the greatest threat to our existence, accidental war?

The U.S. and Soviet Union have more than 10 arms control agreements between them. Some have been in effect for more than 20 years. Many more verifiable arms reduction and accidental war prevention agreements are needed.

CHALLENGE TO ACTION

Since increasing concern for an accidental nuclear war can help prevent it, we need to assess the reasons for low awareness. Consider the following reasons:

Most people are reluctant to think about it.
Accidental war dangers are frequently described in less frightening terms, e.g. confidence-building measures, destabilization.
All nations are secretive about accidental war dangers, e.g. weapons accidents, false warnings, personnel problems.

Herein lies a great challenge. Can the complex danger of an accidental war be made so readily understandable to humanity that there is a great surge for the prevention steps outlined above. This Summary is being sent to the leaders of all nations through their United Nations Ambassadors. It is also being sent to all U.S. Senators and Congresspersons as well as numerous other people. Summaries are available in Spanish, French and German.

We never met a person who is opposed to preventing an accidental war. How content are you to make no effort to prevent the accidental destruction of your family, country and world?

Herein lies a great challenge ...
... Your suggestions and any information on this subject will be appreciated for further researches; Please write to Dean Babst, 7915 Alma Mesa Way, Citrus Heights, CA 95610.

Many people and organizations provided encouragement, invaluable materials, and relevant suggestions.

Center for Defense Information, Wash., D.C.
David C. Morrison not only wrote Chapter VI but contributed to the entire book. Gene R. LaRocque, Rear Admiral, U.S. Navy (Ret.) and Eugene J. Carroll, Jr., Rear Admiral, U.S. Navy (Ret.) wrote letters of support.

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Last, but not least, we wish to thank our families for their continuous support and understanding in this long and difficult task.

Selected Bibliography On Accidental Nuclear War

There are many books and articles that make reference to accidental nuclear war possibilities. These materials are cited in our review and listed in the references for each chapter. There are, however, remarkably few books or booklets mainly concerned with the possibility of accidental or unintentional nuclear war. These books are listed below.

1. *Accidental War: Some Dangers in the 1960's,* The Mershon Report, Housmans, London, 1960.
   (One of the first booklets published on accidental war)

2. Frei, Daniel. *Risk Of Unintentional Nuclear War,* Allanheld, Osmun Publishers, London, 1983. (This book has an extensive bibliography on materials related to nuclear war)

3. Calder, Nigel. *Nuclear Nightmares,* The Viking Press, N.Y., 1980.

4. Leitenberg, Milton. "Accidents of Nuclear Weapons Systems." In: Stockholm International Peace Research Institute (Ed.): *World Armaments and Disarmaments, SIPRI Yearbook 1977.* Cambridge, Mass. and London, The MIT Press.

5. Aldridge, Robert C. *First Strike: The Pentagon's Strategy for Nuclear War,* South End Press, Boston, MA, 1983. (Describes technological momentum behind the nuclear arms race that is driving nations to become increasingly concerned with first strike possibilities)

6. Cox, Arthur M. *Russian Roulette: The Superpower Game,* Times Books, New York, 1982.

7. Britten, Stewart. *The Invisible Event,* The Menard Press, London, 1983.

Chapter I. WHY STRESS ACCIDENTAL WAR

A. Accidental War Is Preventable

The purpose of this review is to increase awareness of the growing probability of an accidental war. The reason for focusing on this increasing peril is to provide the world a unifying force for peace. Like the threat of an invasion from another planet, hopefully the very real threat of an accidental war could start nations vigorously working together for their mutual security.

The desire for "defense" drives the arms race. And yet the threat of deterrence can not prevent an accidental war. We have reached the point where the weapons themselves have become the greatest danger to humanity. People need to be able to grasp this dilemma.

Support for the arms race is based on countries' fear of each other. When nations become more fearful of an accidental war than of each other, then the following will occur:

- Greater concern and efforts by all nations for arms reduction agreements.
- Realization that time is precious. The longer it takes for arms reduction the greater the probability of an accidental war.
- Increased willingness to share information for mutual security, e.g. false alarm problems, terrorist activities, weapons' accidents.
- Increased concern for accidental war prevention measures, e.g. Accidental War Assessment Center, improving "hot line."

No thinking person wants a nuclear war. Yet day by day nuclear war plans are being made, and nuclear weapons are being held on alert in at least five major nations. No one can be sure what event might trigger a nuclear war causing a holocaust that could result in the destruction of civilization. Most of us hesitate even to think about this terrible possibility and yet we must, at least for the sake of the children.

In this review, accidental war is used in the broadest sense to include any way a war could start unintentionally, i.e. by false alert, mistake, crash, first-strike edginess, and unintentional escalation. The term accident is used because it is widely understood. All have experienced an accident in one form or another.

An accidental war is far more likely than an intentional war, because to intentionally start a war would in all probability be to commit suicide. It is difficult to conceive of the U.S. and U.S.S.R. spending vast sums annually for defense to deliberately destroy all. It is generally agreed that neither nation can defend itself against crushing retaliation (1). With many nuclear weapons set for hair-trigger response, the probability of a limited exchange is nearly non-existent.

General Douglas MacArthur pointed out the meaninglessness of intentional nuclear war. "Global war has become a Frankenstein to destroy both sides. No longer is it a weapon of adventure - the short-cut to international power. If you lose, you are annihilated. If you win you stand only to lose. No longer does it possess even the chance of a winner of a duel. It contains now only the germs of double suicide" (2).

This review will attempt to increase awareness of the accidental war peril by providing information so that readers can assess the danger for themselves. Every effort has been made to keep this review short and easily understandable (nontechnical). Each of the fifteen ways (scenarios) that described how an accidental war could start have elements of the following to help in judging their danger.

. Examples of how the scenarios could trigger a war.

. Some indication of size and scope of the danger.

. Some indication of frequency and trends of the danger.

B. Arms Race Is Increasing Probability Of An Accidental War

While an intentional nuclear war is very unlikely, the possibility of an accidental war is growing. U.S. Senator Henry

Jackson said, "For a long time, most people imagined that if a nuclear war ever broke out, it would begin with a premeditated and carefully planned surprise assault. Today, however, it is more and more being recognized that a nuclear war could break out even though neither side wanted it. It could break out not by deliberate intent, but by accident or misunderstanding" (3).

It is frequently said that nuclear weapons have preserved the peace for nearly 40 years. While there is some truth to this statement, it overlooks the dynamics of the arms race. Rapid technological advances are making the arms race increasingly dangerous. Time for decision making has decreased from many hours to minutes. As weapons become more complex, widespread, powerful, accurate and numerous, the possibility of a war starting by accident grows.

Herman Wouk, author of *Winds of War* said, "we are trapped in a monstrous and incredibly frightening and dangerous closed loop of insanity with the Soviet Union. ---- Possibly the most gruesome thing is that everybody has come to take the whole horrible lunacy for granted" (4).

There is no advantage in being the strongest or greatest nation, if we can be destroyed by accident. The U.S. and U.S.S.R., which have the most nuclear weapons, need to lead in making the World secure from accidental destruction. It is sad to think of our beautiful World dying in vain by accident. This is especially true, since by working together we can prevent it from happening.

C. Secrecy By All Nations Decreases Awareness

Nations generally do not report information on false alerts and nuclear accidents so there is a tendency to be little aware of the peril confronting us.

Despite many areas of secrecy by all governments, there is still much information on accidental war. This book pulls together pertinent aspects of this information in order to assess the overall danger as accurately as possible. In the repeated reviews and refinements of this review we asked for and used primary sources

whenever possible. We have also received much help from government agencies. Their positions are carefully stated in the review and acknowledged.

There is a recent excellent book, *Risk of Unintentional Nuclear War* (5). This book, published in cooperation with the United Nations and many governments, is concerned with various theoretical routes by which a nuclear war could start unintentionally. Our review differs from the earlier book in that it focuses more on specific ways a war could start accidentally and provides more examples. We highly recommend Dr. Daniel Frei's book for those who want to pursue the subject further. It has a fine review of the literature, which is not repeated here.

Two other studies should be mentioned. *Accidental War: Some Dangers in the 1960's* was funded by Colonel Ralph Mershon (6). It was one of the first reports to describe various ways an accidental war could start. It has an Introduction by Bertrand Russell. Another book, *Nuclear Nightmares* by Nigel Calder, vividly describes some ways a nuclear holocaust could start accidentally. He points out that there are remarkably few people in the world who take a broad overview of the problem (1).

An extensive survey of the literature was made. Part of this survey consisted of reviewing 20 years of the *Peace Research Abstract Journals* published by the Peace Research Institute (7). In undertaking this massive review, it was observed that for many years there were few references to accidental war. Only in recent years a small but growing number of studies are appearing, a development which inspires hope. Compared with the magnitude of the danger, however, the number of studies on accidental war are still minuscule.

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6. *Accidental War: Some Dangers in the 1960's,* The Mershon Report, Housmans, London 1960.

7. *Peace Research Abstracts Journal,* Peace Research Institute, Dundas, Ontario, Canada, 1964-1983.

Chapter II. DECREASING TIME FOR DECISION MAKING

A. Decreasing Time For Decision Making Increases The Probability Of An Accidental Nuclear War

The time available for deciding whether to launch a nuclear attack or not has decreased through the years. In the 1950s, it would have taken a bomber 12 hours to make a 6,000 mile intercontinental flight (1). Presently the time for making decisions is down to minutes and decreasing.

Due to crises and false alarms*, a decision whether to launch nuclear missiles or not has to be made repeatedly. As the number of nations with nuclear weapons grows, the possibility of a decision to launch increases. It could take only one wrong judgment to start a nuclear war. It could be difficult to prevent an exchange from becoming a holocaust.

Assess each of the following dangerous developments in the arms race individually. Then consider how these developments as they combine or converge could greatly amplify the peril. Most analyses of the danger of decreasing decision time are done in terms of one weapons system at a time. In order to realistically understand the danger, however, we need to take a global view and think about the following major changes simultaneously.

Pershing 2 Deployment In Europe

The 108 Pershing 2 missiles to be deployed in Germany can take out Soviet missiles in their silos with only six minutes warning.** Owen Chamberlain, Nobel prize physicist, describes in the following

* It is highly likely that all nations' warning systems have false alarms. For example, during one 18-month period, the U.S. had 147 false alarms in its strategic warning system (2). This problem is discussed more fully in the next chapter.

**The Pershing 2 will have a flight time of 11 to 14 minutes. The Soviets will only have 6 to 8 minutes for stopping launches due to false alerts. Reaction time after an attack has been verified as less than flight time. Then there has to be a few minutes for launch decisions.

manner how this reduced time allows the Soviets little time to stop a false alarm attack on the U.S.

"Picture the Russian counterpart of our own men who sit in front of radar screens and try to discern among all the incoming signals any that may be a threat. Now picture the Russian in the dark in front of his screen suddenly noticing high velocity objects accelerating from a region where he knows Pershing 2 missiles are to be deployed. By now he has used one minute, for it has taken his computer one minute to identify new objects on this screen among the hundreds that are routinely orbiting the earth. He now has five minutes or less. And I should say not only he, but the entire command structure of the Soviet Union has 5 minutes or less to decide how to respond. Perhaps a minute passes while the operator confirms his observations with another operator. And we would hope he doublechecks his equipment. Now there are less than four minutes. He must alert his commander, who in turn is to contact Andropov, who could even be vacationing with his family at the moment. Andropov, having been reached, realizing that his weapons might be destroyed in their silos in a real attack, must evaluate the likelihood of an attack in the existing political context. Has the U.S. been acting in any way that makes an attack likely? It would have to be a flash judgment, to be sure, because at the most there may be two minutes left before doomsday might strike. If he could reach the U.S. president on the hot line, he has seconds left to decide whether the American president is telling the truth or lying when he insists there has been no deliberate attack.

"For just a moment put yourself in the position of each person along the chain of decision. It has taken us almost four minutes to consider this proposition" (3).

Cruise Missile Deployment in Europe

The deployment of cruise missiles in Europe compounds the Soviets' problem of analyzing false alerts. While the Pershing 2 reduces warning time to minutes, the cruise missile opens up additional uncertainties. With the cruise missile the Soviets can never be certain how much warning, if any, they have, thereby

increasing the danger of an accidental war. The following illustrates the complexities of the danger.

. Since cruise missiles are designed to slip under the eye of radar, a nation can be under attack before they realize it. These missiles are virtually undetectable by radar, due to their small size and the treetop altitude at which they fly (4, p. 143).

. As the number of cruise missiles placed in Europe grows, it can aggravate the assessment and correction of a new type of false alarm in at least two ways:

-- If Soviet early warning sensors detect many aircraft or conventional-armed cruise missiles taking off simultaneously, it may resemble the launch of long-range nuclear cruise missiles. Then, if due to a jamming environment or other phenomena the sensors lose contact, Kremlin leaders in time of severe international tensions might believe a wave of nuclear-armed cruise missiles is on the way. They may even suspect the wave is larger than the number actually detected because other cruise missiles could be launched unseen.

-- Even these uncertainties are increased by both sides awareness that military planners are continually trying to develop ways to confuse detection and verification devices (e.g. U.S. Ground Launched Anti-Ship System - GLASS) (5). Cruise missiles slow speed (2 hours flight time) could be irrelevant if undetected.

-- If a U.S.S.R. early warning sensor picked up an unidentified or stray low-flying aircraft close to a sensitive target, it might be misread as a cruise missile. In this case the time element may be critical. Under crisis conditions Soviet leaders may reason that a wave of cruise missiles is heading their way and, unable to resolve the false alarm, fire their own missiles.

The point to be recognized here is that deploying cruise

missiles introduces a new set of phenomena to be detected and characterized. Whereas unidentified aircraft today would not be likely to trigger. World War III, the introduction of long-range, low-flying, nuclear-armed cruise missiles will change the picture drastically. If one feels these scenarios are far-fetched, it would be well to remember that the shooting down of a stray passenger airliner was considered unlikely prior to September 1983. It should also be recognized that the Soviet air defense system, considered the most elaborate in the world, had tracked the ill-fated Korean 747 aircraft for over two hours prior to knocking it out of the sky with a rocket -- apparently still unable to determine that it was a harmless jetliner. This does not instill confidence in Soviet tracking and characterization sensors.

. The European cruise missiles could attack the Soviets with no warning since they will be ground-launched cruise missiles (GLCMs). This means that the missiles can remain low to the ground from launch, flying undetected under radar. GLCMs have a range of 1,500 miles (6) which is sufficient to reach Leningrad and Kiev from England and Sicily respectively. When GLCMs are deployed in Germany they will be able to hit Moscow's command centers.

. Radar is the central means of alerting nations against bombers and cruise missiles (4, p. 191). Another element for alerting is the satellite. Until the Soviets can develop something similar to the U.S.'s Teal Ruby,* their satellites cannot identify cruise missiles with certainty. Cruise missiles are difficult to detect because they have small radar and infrared signatures compared with ballistic missiles (7). In such a situation, if the Soviets think they see an attack they could launch because of a false alarm.

* The first Teal Ruby sensor is scheduled to be placed in space in 1986 (8, p. 121). Teal Ruby will be a network of satellites/space stations capable of spotting and tracking aircraft and cruise missiles from space. It will use a mosaic of about a quarter-million infrared detectors with integral data processing capability. Each detector will "stare" along a given line to achieve great sensitivity and all of them together will provide a wide field of vision.

Soviets' Countermoves to Offset U.S. Missiles

In response to the deployment of Pershing 2 and cruise missiles in Europe, the Soviets plan a series of countermoves. One move is to deploy "operational-tactical" nuclear missiles in East Germany and Czechoslovkia (9). This countermove will reduce NATO's warning time.

Soviet General Nikolia Chervov, in October 1983, said that the Soviets might deploy submarines armed with nuclear missiles 100 miles off the U.S. coast. "The Pentagon's alarm is understandable: Soviet submarines close to our shores could hit major U.S. targets - including Washington, D.C. - with virtually no warning. And using a still-theoretical technique called ' depressed trajectory,' the subs could fire their nuclear missiles like artillery shells and hit targets well inland in six minutes or less.

"This would give the United States little time to retaliate - or to determine whether it was a genuine Soviet attack, a false alarm or an accident. The time for a decision whether to launch a global nuclear holocaust would be counted in seconds. There would be no opportunity for a president to weigh the available options, get on the hot line to Moscow - or even make it safely to his getaway plane"(10).

Moving more Soviet submarines closer to the U.S. would place the United States in a position similar to the one faced by the Soviet Union if the Pershing 2 missiles are deployed in Western Europe. Marshall Kulikov, commander in chief of the Warsaw Pact forces, said the short warning time "would make it practically impossible to prevent a conflict resulting from an error or a technical fault"(11).

Cruise Missile Race

The number of cruise missiles in the world is significant and growing. The U.S. has already placed them on B-52 bombers and on the battleship New Jersey. "U.S. plans call for the construction of 9,000 cruise missiles. More than 5,000 of them will carry nuclear explosives. Hundreds of billions of dollars and rubles will be

spent on offensive and defensive arms in attempting to adapt to the cruise missile revolution"(6). The Soviets are developing a variety of cruise missiles. Some of their long-range cruise missiles that can be launched from bombers and submarines will be operational by the mid-1980s (12). The effectiveness of French cruise missiles was demonstrated when Argentina used one to sink a British destroyer in the Falklands war. The number of directions from which a nation can be attacked with devastating force and no warning is growing.

Present U.S. anti-submarine warfare capabilities against the Soviet ballistic missile submarine force are such that those subs tend to stay in protected waters near the Soviet Union in order to preserve their survivability. This extends the warning time available to the U.S. But a large number of Soviet submarines armed with land attack cruise missiles, would make the U.S. anti-submarine warfare efforts much more difficult. Even if only a few Soviet cruise missile subs (each with upwards of 25 missiles) managed to penetrate close to the U.S. coast, there would be little or no warning time (12).

A dangerous situation could occur if the U.S. thinks a Soviet cruise missile submarine has penetrated and it sees a cruise missile attack. The uncertainty could cause a lot of nervousness in the Pentagon war room.

Defense specialists are also concerned about cruise missiles for other reasons. "Cruise missiles are easily concealed, which means that every Soviet fishing trawler could become a potential missile 'delivery' system. That would produce nightmarish command-and-control and destabilization problems for both sides (13).

As the possibility of an attack without warning grows, the premium on "shooting first" will increase. "Already, competition between the two superpowers' naval fleets has reached such a tempo that Secretary of the Navy John Lehman believes a spark could set off not a small, containable conflict but an 'instantaneous global naval conflict'"(14). Since neither side can destroy the other without retaliation we are moving toward mutual suicide.

Stealth Bombers

As nations deploy more and more weapons designed for sneak attack, the number of situations in which "hair-trigger" decisions will have to be made will grow. The U.S., for example, is developing a B-1B bomber as a cruise missile carrier. This bomber is being made as invisible to radar as possible - stealthy. Through electronics and airfoil design, the B-1B will be tough to find and track on defensive radar screens. "The B-1Bs will appear ten times smaller than the first B-1s - 100 times smaller than the B-52s"(8). At low altitude, radar detectors won't be able to find the blip of the approaching bomber and distinguish it from the terrain. It is faster than the speed of sound (Mach 1). "It'll blend into one glowing, green smudge"(15).

In addition to the B-1B bomber, the U.S. plans to build 132 Stealth bombers (16, p. 17). These bombers will be designed to have an even greater surprise attack ability than the B-1B bombers (4, p. 152).

Additional Dangerous Developments

As if the above dangers were not enough, there are additional developments that compound the danger of an accidental war. The remainder of this review describes them. Two are listed below to illustrate.

- As the number of nations with nuclear weapons and the ability to deliver them grows, more nations will become increasingly edgy. They could become more nervous because it would take fewer weapons to destroy a small nation, and being closer together, they will have less time. Could a small nuclear war trigger a global war or vastly affect the earth's climate?

- As warning time decreases, the time allowed for deciding who should seize the first strike advantage in a crisis becomes more urgent. Chapter V describes this danger.

U.S. Rear Admiral Eugene Carroll (Ret.) makes the best summary of the situation. "If we, and the Russians, continue to deploy ever more capable and time sensitive nuclear weapons systems, we will

both be forced to develop fully automated decision systems which will have integrated strike enabling capabilities. When this happens, it will no longer be accurate to describe a war started by computer error as 'accidental'. It will be inevitable, and a logical consequence of our mutual stupidity"(17).

B. Responses Of U.S. Officials To Accidental War Concerns

During 1983, questions on accidental war and sections of this review were sent to U.S. government officials for comments and suggestions. We received many useful responses from the U.S. Department of Defense, the U.S. Department of State and the U.S. Arms Control and Disarmament Agency. When their responses pointed out inaccuracies in our statements, we have modified them accordingly. Where they have provided key information, we have acknowledged their help. Most expressed a concern about preventing an accidental war.

When Secretary of Defense, Casper Weinberger, was asked, in a News Conference on April 12, 1983, how concerned he was about the possibility of miscalculation or accidental use of nuclear weapons he said, "Well, we have to be very concerned. That's always a possibility. The weapons are here. The weapons cannot be put back in the bottle as they say and so we are always going to have to be concerned that there not be any of the horrors of war unleashed by accident, ambiguity or mistake. Yes, it's a matter of continuing concern and always has been"(18).

C. Differences Of Opinion On Dangers In Deploying Pershing 2 And Cruise Missiles

It can be expected that on any issue as complex as deploying Pershing 2 and cruise missiles in Europe, there could be differences in view as to the dangers involved. In this respect, the following statements show another side to the issue. The statements also contain some very valuable information not generally available.

In response to an earlier draft of Chapter II, Brigadier General Elmer Brooks, USAF, responding for T.K. Jones, Deputy Under Secretary Strategic and Theater Nuclear Forces made the

following statements.

"Thank you for your recent letter and attached draft Chapter II concerning deployment of cruise missiles in Europe. We appreciate your interest and constructive ideas regarding deployment of NATO's non-strategic nuclear forces. However, we feel the cruise missiles and Pershing II are required to maintain the Alliance deterrent capabilities in the face of expanding and modernized Warsaw Pact nuclear forces and, in particular, to the Soviet deployment of SS-20s. We also believe that the Soviet response time is not reduced to near zero. Let me explain our rationale for this position."

"The underlying premise of Chapter II is incorrect with respect to present trends in cruise missile development leading toward "little or no time" to react to a false warning. To the contrary, the speed and flight time of the cruise missile, GLCM in particular, are such that up to several hours of "assessment" are possible prior to a decision to execute this force. The potency of the cruise missile is based on numbers and not the capability of an individual missile with a single warhead to do insurmountable destruction."

"The Soviet Union has adequate capability to detect the potential and actual launch of GLCM. Their extensive base of "agents" will know when GLCM trucks are taken out of their main operating bases and deployed. In addition, the Soviets have deployed redundant radar detection sites capable of detecting GLCM many hours before reaching their targets. The cruise missile is a low observable but not invisible. Specifically, GLCM does not have a lower cross section vehicle than a ballistic missile. It is precisely the slow speed of GLCM that precludes its use as a first strike potential weapon, as opposed to ballistic missiles."

"The arguments for Pershing II are somewhat different since it is a ballistic and not a cruise missile. PII flight times are short, but the range of PII is limited so that Moscow and beyond cannot be reached from the planned PII bases and deployment areas. Consequently, although warning time is short, the Soviets need not fear PII use as a first strike weapon against critical Soviet targets."

"In summary, the cruise missile in Europe (GLCM) is a stabilizing weapon. It provides an in-theater deterrence capability for selective employment against Soviet targets without posing the threat of first strike potential. Its credibility is enhanced by the potential to launch relatively large numbers, as opposed to fast time to target. GLCM and Pershing help to eliminate any incorrect perception that the Soviet Union could operate from a sanctuary since Soviet planners may question the U.S. commitment to launch intercontinental weapons at the Soviet Union if the Soviets used nuclear weapons in Europe. With survivable long range weapons in Europe, the Soviets must rethink this issue"(19).

Donald C. Latham, Deputy Under Secretary of Defense (C^3I) in responding to an earlier draft of Chapter II, provides the following information.

"There are important misconceptions in the draft. For example, the task of warning of a cruise missile attack appears to have been confused with the more difficult task of defending against it. It is a matter of public record that the Soviets have about 7,000 radars dedicated to aircraft detection and engagement functions. Given this and the fact that the time of flight of cruise missiles over the ranges you have stated would be several hours, it seems apparent that the Soviets would have ample time and opportunity to screen false alarms long before key targets would be threatened. It should also be noted that the Soviets are well equipped, for example with 600 modern strategic interceptors, to take active defensive actions if they felt they were being threatened. It is also a matter of public record that the Soviets do take such actions, so that there is no need for them to initiate offensive actions in response to a false alarm"(20).

In reference to Pershing II deployment, Colonel Merril B. Walters, USAF, Deputy Director Theater Nuclear Policy, made the following statements.

"Regarding your contention that the PERSHING II flight time to target point is typically six minutes; that is in fact, not the case. The flight time to the targets in the western USSR would

almost in all cases be between eleven and thirteen minutes.* Allow me to remind you that Soviet YANKEE class nuclear powered ballistic missile submarines which have routinely patrolled in the western Atlantic for many years, can strike Washington D.C. in six-to-ten minutes, as we know from their routine deployment patterns. Additionally, the SS-20 flight time to most Western European capitals and C^3 centers is either equal to (in some cases) or less than that of the PERSHING II."

"Two other points are central to your questions concerning the PERSHING II: first, the PERSHING II is not analogous to the missiles of the MINUTEMAN family in any way except for the fact that launch can only occur after approval has been secured from the National Command Authority (i.e. the President); secondly, in wartime, the PERSHING II missile will be under the operational control of SACEUR. A final point relating to this missile system is that our deployment of PERSHING II's will support NATO's strategy of flexible response; the PERSHING II is not likely to be used in a launch-on-warning scenario. Its primary purpose is to deter potential Soviet aggression, as is the mission of all of our nuclear weapons"(21).

D. Assessing Danger Of Intermediate-Range Missile Deployment

In the previous statements, the Department of Defense officials are saying that deployment of the Pershing 2 missiles and cruise missiles add to our security. In our statements, in the first part of this Chapter, we express grave concern that the deployment of these missiles is increasing the danger of an accidental war. Since our mutual goal is to gain as accurate an understanding of the common danger as possible, let us consider these differences. We have separated this complex problem into the following issues for further thinking.

1. Colonel Walters states that the flight time of the Pershing 2 would in almost all cases be between 11 and 13 minutes

* Authors' note: The Pershing II will have a flight time of 11 to 14 minutes. The Soviets will only have 6 to 8 minutes to stop their launches due to false alerts because reaction time is less than flight time.

and not be 6 minutes.

Many scientists disagree and say that the Pershing 2 can reach the western Soviet Union in 5 to 10 minutes (22). Even 13 minutes can be too short. How strange that we should be decreasing the time allowed the Soviets for eliminating false alarms before launching their nuclear missiles at us. We have absolutely no knowledge of their false alarm experience. Could not such mass blindness be the same as suicide? If not, why not?

Colonel Walters' statements remind us how great the danger is now of an accidental nuclear war, e.g. the Soviets can strike Washington, D.C. in six-to-ten minutes, and the Soviets' SS-20s' flight time to most Western European capitals and command centers is equal to or less than that of Pershing 2. The Soviets' planned countermoves, moving their missiles closer to NATO and the U.S. could be equally suicidal.

2. General Brooks said the Soviets need not fear the Pershing 2, as a first strike weapon since it can not reach Moscow from planned deployment areas.

   Contrary to the above statement, many scientists say the Pershing 2 can hit Soviet command, control and communication centers (22). Also once deployed in West Germany, the missiles could be moved even closer to the Soviets.

   With only a few minutes allowed to assess whether a warning is false or not, how can the Soviets be sure a warning is not the cutting edge of a massive first strike using many weapons systems?

3. Colonel Walters has said that the Pershing 2 can only be launched after approval has been secured from the U.S. National Command Authority or in wartime from Europe's SACEUR.

   How much assessing and conferring can be done on a global

basis in six minutes or less by either side. Dr. Chamberlain's description of warning time sequence events, at the beginning of this Chapter, shows how little can be done in six minutes.

4. Dr. Latham points out that the Soviets have about 7,000 radars to warn against an attack, so how could they be surprised by cruise missiles that take several hours flight time?

The cruise missile scenario described in the first part of this Chapter illustrates one way it could happen. Note, for example, that two of the Russian radar units were reported as not working when they shot down the Korean airliner (23). Some American military officials say that the Soviet early-warning system is less up-to-date than the U.S. These officials point to many instances of slow and mistaken Soviet identification of aircraft (24).

. General Brooks said he feels the cruise missile and Pershing 2 are required to maintain the Alliance's deterrent capabilities.

This is a heavily debated issue with prominent spokesmen on both sides. We agree with former Secretary of Defense, Robert McNamara, that if NATO used its nuclear weapons the war would escalate into an all-out Soviet-American nuclear exchange -- suicide (25). Given this premise, the deploying of the Pershing 2 and cruise missiles in Europe only adds more useless nuclear weapons at the cost of increasing the possibility of our accidental destruction.

6. All of the Department of Defenses' responses are one dimensional. None of the responses reflect on how deploying Pershing 2 missiles and cruise missiles together could compound the danger. That is, not only is warning time decreased but even that time is made increasingly uncertain as the number of cruise missiles in operation grows, thereby amplifying the danger of launching to a false warning. The danger is increasing exponentially when you add in the

Soviets' countermoves, stealth bomber deployments, human frailties and the many other dangers described in the remainder of this review.

As our thinking has evolved, we have become increasingly concerned about the compounding impact of many simultaneous developments. Therefore, the entire review, in next to final form, was given to DoD for further comments and suggestions on November 17, 1983. On January 13, 1984, designated liaison, Bettie Sprigg, said DoD was working on a response. A copy of their reply may be obtained upon request from Dean Babst.

E. Decreasing Time and Human Frailty

A recent very honest statement by former Secretary of Defense, Robert McNamara, shows the critical importance of human frailties and the time needed for decision making.

"Are you so certain we'll never have again, in the whole history of the human race, have another conflict?". I'm not. Read history; look at the events of the past two weeks. Look at Berlin in '61 or Cuba in '62, or the events since that time. We damn near had war in '67. I'll never forget, I went to the Pentagon, as I always did at seven in the morning, and at 7:15 the Duty Officer called, it was in June of '67, and he was an admiral (we kept flag officers then, and I presume we still do, 24 hours a day, seven days a week in the War Room to be sure we were on top of what was going on). He called and he said, "Mr. Secretary, Kosygin wants to talk to the President. What should I say?" And I said, "Why the hell did you call me?" And he said, "Well, the hotline ends in the Pentagon." Now I'd been Secretary seven years and the hotline went in -- I've forgotten when -- '61, so the hotline had been there six years. I didn't even know it ended in the Pentagon. This was the first time the hotline had ever been used (excepting only for exercises). And he said (as you know, it's not a telephone, it's a teletype), and he said, "The teletype station, or the end of the hotline is in the Pentagon." Damned if I knew it. But I said, "Look, we're spending $80 billion a year for defense. You better get a few of those damn

dollars and get that hotline patched over to the White House immediately. And I'll call the President and tell him Kosygin wants to talk.: So I called him (and I knew Johnson never was up at seven o'clock in the morning) and he had an Air Force sergeant that sat outside his door to take messages like this. So the sergeant came on the line and I said, "Sergeant, I want to talk to the President." And he said, "He's asleep," And I said, "Hell I know he's asleep; wake him." He said, "He doesn't like to be awakened." "Well," I said, "God damn it. I don't care whether he likes to be awakened or not, awaken him." So we wakened him and Johnson came on the line and, you know, he's groggy and sleepy, and he says, "God damn it, Bob. Why'd you call me this time?" I said, "Mr. President, Kosygin wants to talk to you." And he says, "What'd you say?" I said "Kosygin wants to talk to you." "What the hell do you mean!"

"Well," I said, "he's on the hotline; hotline ends in the Pentagon..."

"Well, what do you think I ought to say?"

"Why don't we say that you'll be down in 20 minutes. In the meantime, I'll get Dean Rusk and we'll meet you down there in the Situation Room..."

So, we get over there and it was one of these very dreary tough messages. I don't know whether it's ever been declassified but the essence of it was "If you want war, you'll have war." We had, you know, Nasser was saying our aircraft were bombing, (which they absolutely were not), the Jordanian forces. We had turned a carrier around in the Med to go from West to East. It had been going West, we turned it around to go East toward Israel, and that's what led to this thing. But the point of the story simply is that: Are any of you prepared to say that we won't bungle into conflict. I'm not. I don't know when it's going to occur, how it's going to occur, but the risk of deterrence failing, the risk of bungling into a confrontation that nobody intended, and nobody wants, and nobody planned, is very high"(26).*

* Emphasis added by authors.

If you think the previous crisis is unusual, then note the many other frightening leadership crises in the U.S., Soviet Union, Britain, France and China described in Chapter IV. When one considers these human frailties and how the time for decision making is decreasing, the severity of the danger becomes more apparent.

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Chapter III ACCIDENTS INVOLVING INFORMATION

A. Strategic Warning System Problems

Overview

If nations' warning systems continue to have serious false alarms and the time allowed for clearing false alarms continues to decrease, then an accidental war seems increasingly certain. Because of this, it is crucial to understand nations' strategic warning systems and their problems.

During one eighteen-month period, the U.S. had 147 false alarms in its strategic warning system (1). Some lasted more than a minute and one lasted a full 6 minutes. Other nations' warning systems may have more false alarms than the U.S. The U.S. Central Intelligence Agency says the Russians need better equipment to process information picked up by their radar and to distinguish warheads from decoys (2). With decreasing time for eliminating false warnings, how long will it be before some nation launches to a false alarm?

Most false alarms are handled long before they become serious. There have been, however, some serious false alarms. Let us examine a few to illustrate the problem. Remember, it may only take one uncorrected false alarm in one country to trigger a chain reaction nuclear missile exchange.

- On October 3, 1979 radar at Mt. Hebo, Oregon picked up a low orbit rocket body that was close to decay and generated a false launch and impact report (3, p. 3).

- On March 15, 1980 four missiles were launched near the Kuril Islands as part of Soviet troop training. One of the launches appeared to the U.S. to project an impact point in the United States (3, p. 3). Testing and training exercises are going on continually.

- U.S. Senator Charles Percy described a false alarm he experienced while at NORAD command headquarters in the following manner. "At the time we had that false alarm - that must have been a

6 minute period because it seems like hours to us - panic just broke out. It was a very frightening and disconcerting thing. You wonder what recommendation they finally would have made at the end of those minutes until they discovered that it was just an electronic problem" (4, p. 210).

The U.S. Strategic Warning System

The following information is on the U.S. warning system because it is the only one on which there is unclassified information. The U.S. worldwide warning system is large, complex and has many critical problems; therefore, this summary is provided so you can assess the possibility of future false alarms for yourself.

Since information on the U.S. worldwide warning system is not widely available and it is crucial to the world's security, a fuller and more technical description of it is provided in Appendix A. Some information on other nations' warning systems is provided in the last part of this section.

The Missile Attack Warning System consists of three major components (1).

1) Sensors to detect missile launch.

2) Computer centers and communication links to analyze and distribute data from warning sensors.

3) Command posts where the implications of the warning information are supposed to be assessed and acted upon.

The system employs a two-step process for identifying a missile launch and assessing threat to the North American continent. The first indication of a missile launch would come from the satellites followed by ground based radar. The dual detection system provides an important cross check for evaluating ambiguous data. Since cruise missiles can attack with little radar warning, how will a cross check be made to assess the accuracy of satellite warnings as the number of cruise missiles grows?

The command and control arm of the U.S. defense is called the Worldwide Military Command and Control System (WWMCCS - pronounced "Wimex"). This system includes the worldwide missile warning system. The North American Aerospace Defense Command (NORAD) provides warning of any attack on North America. NORAD is a functional partnership between the United States and Canada. In the wake of the 1979-80 false alarms, NORAD has been disengaged from reliance on WWMCCS.

Satellites and radar feed their data directly to four major command posts:

NORAD Cheyenne Mountain, Colorado

SAC (Strategic Air Command) Nebraska

NMCC (National Military Command Center) Pentagon

ANMCC (Alternate National Military Command Center) Fort Ritchie, Maryland

When there is any indication of a real threat or even ambiguous data, the four command posts begin a formal conferencing procedure to evaluate the data. How would this conferencing be handled if there were no time?

The warning process is triggered by observing the infrared* signatures of the missiles. Unfortunately there are other physical phenomena that can give similar infrared indications. The detection system must be sensitive enough so as not to miss any missile launches, but still not overburden the system with irrelevant information. There are many minor problems of this type. In addition there is the possibility that a computer or piece of communication equipment will transmit a false piece of information. A speck of dust can create problems.

As a result of the 1980 false alarms, many improvements have been made in the system. See Appendix A. U.S. Senator Barry

* Heat waves - Ed.

Goldwater has asked the Department of Defense to make a new false alarm study. We recommend that each nation with a strategic warning system make a registry of its serious false alarms, and share these data in such a way as not to compromise the future of each nation's system and yet stop the other nations from doing anything "foolish".

Problems With The U.S. Warning System

Despite improvements, the U.S. early warning system still has serious problems. An extensive investigation of the NORAD/WWMCCS system was made by the U.S. House Committee on Government Operations and General Accounting Office (GAO). The following illustrative observations were taken from their report of March 1982, authored by Chairman Jack Brooks (5).

- "Further, it was found that the NORAD facility had been mismanaged over the last decade by the Air Force, the Joint Chiefs of Staff, and the Department of Defense, resulting in obsolete computer systems which do not satisfy the requirements of NORAD's sensitive mission. These obsolete systems, coupled with poor management practices and human error, were directly responsible for the false alerts."

- "The severe and potentially catastrophic deficiencies found in the Nation's missile attack warning system are a result of significant and long-term management failings within the Air Force and the Joint Chiefs of Staff. Continued inability to correct these failings by the highest levels within the Department of Defense will continue to perpetuate past mistakes and, will undermine any chance that an effective attack warning or command and communications system can be installed by 1990."

According to a June 25, 1983 news release, saboteurs can tap into U.S. military computers. "Defense Department computer experts, organized in 'tiger teams,' have been able to "break into every one of the computer systems that they targeted," Navy Lts. Peter Grant and Robert Riche wrote in the July issue of *Proceedings*, the highly respected journal of the private U.S. Naval Institute in Annapolis, Md. (6).

"Even systems advertised by manufacturers as 'secure and unbreakable' were penetrated by the experts in a relatively short time, the authors wrote" (6).

Grant and Riche described techniques such as "trap door" and "Trojan horse" that could be used by saboteurs to penetrate a country's military computer system. They said such techniques could be used to garble information necessary for anti-submarine warfare or to command missiles in flight (6).

In a scenario much like that in the hit movie War Games, a group of Milwaukee youths used home computers to tap into computer systems across the nation. They broke into computer systems at a California bank, several private companies and - ominously - the national nuclear-weapons laboratory in Los Alamos, New Mexico (7).

November 2, 1983, a 19-year-old UCLA student was charged with using a home computer to break into a Defense Department communications system linking government and private computers throughout the United States and Europe. Some of the information was very sensitive (8). With a growing number of home computers and many nuclear weapons in the world, when could a serious accident occur?

Difficulties In Understanding Accuracy Of Warning Systems

Great care has to be exercised in assessing the accuracy of nations' warning systems. For example, NORAD's description of their computer system is very glowing and does not reflect the dangers mentioned by the House Committee on Government Operations and the General Accounting Office.

The Center for Defense Information received a letter from NORAD which included a three page "Fact Sheet On NORAD Computer System." The Fact Sheet listed many improvements they had made and concluded as follows. "NORAD's positive management actions have been recognized both by the House Committee on Government Operations and the General Accounting Office whose May 1981 Report states: "NORAD has instituted significant changes in its acquisition and management of computer resources. It is making excellent progress toward planning future improvements based on sound definition of

requirements in overall missile warning system architectures." (9).

We do not doubt the accuracy of NORAD's statements and we are pleased that they are making progress as recommended by Congress and GAO. However, what they did not say is very significant. The June 30, 1983 letter from NORAD only listed favorable comments from the May 1981 report. It made no reference to many serious problems discussed in that report or in a later report (March 8, 1982) entitled, *NORAD Computer Systems Are Dangerously Obsolete* (5).

In response to an earlier draft of our Chapter on false warnings, Donald C. Latham, Deputy Under Secretary of Defense (C^3I) made the following statements to authors on Sept. 26, 1983.

"The most serious misconception in the draft is that an accidental war could be triggered by a false warning. This is certainly not the case for the U.S., and there is strong circumstantial evidence that the Soviet Union is capable of preventing such an occurrence. The U.S. is equipped with a redundant sensor system which exploits several kinds of phenomena. The elements include satellite sensors for detecting missile launches; ground-based radars for confirming the satellite warning; and sensors for detecting the occurrence of nuclear detonations. We have highly trained and experienced personnel in charge of all phases of the warning process, and there is no chance that any irreversible action would be taken based on ambiguous information. In this regard, your attention is called to the April 1983 Report of the President's Commission on Strategic Forces, which clearly emphasizes the need for a capability to retaliate after attack -- "after massive nuclear detonations had already occurred on U.S. soil."

"While we do not have access to the Soviet position in this respect, we do know that they also have a redundant sensor system, which includes large over-the-horizon radars and launch detection satellites, reinforced by a network of so-called HEN HOUSE radars near the borders of the USSR. The Soviets have made a major commitment to improving this network by building new phased-array radars on their borders. In addition, the Soviets maintain the world's only operational anti-ballistic missile system, which again gives

them a defensive option and relieves the need for them to react offensively to a false alarm"(10).

Following the above response, we wrote to Dr. Latham on October 3, 1983, asking, "Is there any specific evidence that can be cited that Congress is now satisfied that DoD has solved the problems raised in its reports, "NORAD's Computer Systems Are Dangerously Obsolete"? We also pointed out how NORAD's Fact Sheet cited information favorable to itself and completely ignores problems raised by Congress. We asked if this huge discrepancy could be explained. As of January 15, 1984 we have received no answer (11).

On August 29, 1983 David Morrison of the Center for Defense Information, wrote to NORAD about two 1978 Threat Assessment Conferences (TAC). On September 29, 1983 he received a response from NORAD saying the information was denied (12). On October 21, 1983, he appealed the denial under the Freedom of Information Act, receiving a reply on October 27 from Brigadier General L.C. Price saying both TACs were convened as a result of a Launch and Impact report received from SLBM warning sensors. The alert status of U.S. strategic forces were not affected. They said the problem had been corrected and further information on these events is classified and not available (13). So, the shortcomings can not be assessed. Why?

Soviet Union Warning Systems

Earlier in this Chapter, Dr. Latham of DoD was quoted as saying there is strong circumstantial evidence that the Soviet Union is capable of preventing a false alarm from triggering an accidental war. How comfortable are you resting the fate of humanity on circumstantial evidence? According to Senator Gary Hart, "No one in the United States knows with any degree of confidence how reliable Soviet personnel and computers are. This ignorance only underscores the importance of taking joint and immediate steps to reduce the likelihood of starting a nuclear war by mistake" (4, p. 208).

According to an article in *New Scientist*, some defense experts claim that Soviet warning equipment is less sophisticated than U.S. apparatus, giving Soviet Commanders less time to make

decisions. This, compounded by the fact that three-quarters of the Soviet's nuclear weapons are mounted in land-based silos which are relatively vulnerable, will increase the necessity for Soviet commanders to get their missiles off the ground at the slightest hint of a NATO or an American attack (14).

The shooting down of the South Korean airliner killing 269 people, illustrates how misunderstandings can occur. When the jetliner flew into Soviet airspace in the dark of September 1, 1983, it set off an elaborate network of radar tracking stations, ground-to-air missile batteries and fighter squadrons that are kept permanently on a near-war footing (15). An official Russian source said two of three radar stations on the Kamchatka Peninsula that should have detected the plane were not working and the plane's intrusion of Soviet airspace was not confirmed until it reached Sakholin Island, 400 miles southwest of Kamchatka (16).

"According to Western estimates, the SU-15 and MiG-23 fighters that scrambled to intercept the 747, and the electronic equipment that guided them on the ground and in the air have serious limitations that may have combined with human factors in a situation that placed the whole system under sudden stress" (15). To add to the confusion the pilots who were sent up to intercept the 747 had to deal with diminishing fuel and a shrinking "window" of time available for decision."

Several senior officials of the Soviet Far East military command were removed from their jobs, for what Soviet sources describe as a massive failure of air defense forces to halt the flight over Kamchatka Peninsula (17).

Other Nations' Warning Systems

While French missiles are limited in number, they are being updated and could do a vast amount of damage. They are on the Soviet SS-20 target list. Since the French are only a few minutes' missile time away from the Soviets, they may be in a launch-on-warning mode now. In that case the World's safety is now dependent on the reliability of French computers (18). The Soviets for their own safety, irrespective of arms control talks, may be wise to pull back

their missiles, allowing Western Europe more time for error correction.

The North Atlantic Treaty Organization (NATO) has an integrated air defense system for Allied Command in Europe. The early warning system has a chain of radar stations from the North Cape to Eastern Turkey.

According to a NATO report, "In the mid-seventies, the growing capability for aircraft to operate effectively at low and very low levels brought with it the need to detect and track aircraft at such levels. Although the ground radar sites provided excellent coverage of the Alliance airspace at medium and high levels, its coverage of the lower altitudes was poor. It was clear from topographical considerations that adequate surveillance of all altitudes would require an extremely large number of ground stations, which would be prohibitively expensive; attention was therefore drawn to possibilities of elevating the surveillance system, and thus the Airborne Early Warning and Control System (AWACS) concept came under consideration by the Alliance" (19).

"Towards the end of 1978, Defence Ministers agreed to procure collectively an AWACS force to provide low level radar cover over NATO territory and the approaches to it. The AWACS fleet will comprise two interoperable elements, the NATO E-3A and the United Kingdom NIMROD, and by the end of the eighties will be capable of operating over sea and land and will be fully integrated with the existing ground environment system"(19). Most U.S. AWACS planes are on the ground most of the time and would not serve a very effective preventive function, but are only useful in crisis management.

Since cruise missiles operate at low altitudes where radar coverage is poor and AWACS will not be available to cover this deficiency for years, how much warning time will NATO have against Soviet cruise missiles?

Considering the problems in the U.S. warning system, it is urgent that nations share their false alarm experience. The security of all nations may be dependent upon the nation with the

least accurate warning system.

Impossible Task?

The demands on each nation's early warning system may be rapidly becoming impossible. As nuclear weapons become more complex and widespread, the workload of warning systems could grow due to increasing data validation needs. As the workload grows the processing of false alarms may take longer, even as less time is becoming available for such processing. Increasing computerization and automation to meet these demands could increase the chance of error-triggered missile launch. If all countries can meet the challenge except one, it may not be enough.

Conventional detection and verification technology for warning systems is based on certain acoustic and other characteristics "signatures" of moving objects. If these signatures slightly vary, nations' early-warning-systems could be misled into making it more difficult to determine which warnings are false or not. See Appendix E for a long list of possible areas for error in the warning systems.

B. Lengthening Command Chain (C^3I) Increases Chance Of Error

In an age of "push-button warfare," nations are building vast, complex communication systems in order to stay in touch with their widely scattered forces. These systems consist of intricate webs of satellites, sensors, radar, computers and underground and airborne command rooms. In the U.S. this area of defense is called C^3I (command, control, communications and intelligence). In the fiscal 1983 U.S. budget, more than $30 billion has been budgeted for it - a 20 percent increase over the last year (20).

While these large, sophisticated systems provide nations with information crucial to their defense, they also provide a growing source of insecurity as the number of nations with nuclear weapons grows.

Under what conditions do those in charge of submarines, bombers or missiles have final say about nuclear weapons use?

A dilemma for each country is: how much decision-making power to delegate to the on-scene commander in a crisis? On the one hand, if central control is too tight the weapons may be unusable in a crisis. On the other hand, if local commanders are given more control over nuclear weapons the opportunity for use through miscalculation will be greater (21). In addition, some of these decisions may have to be made with little or no time for assessing situations. One wrong decision may be too much.

As the first cruise missiles began arriving in England (Nov. 1983), an opinion survey showed 94 percent favored giving Britain equal physical command of the missiles with Americans. Nearly 70 percent said they thought the weapons would be fired over British objections despite repeated government assurances that the United States has pledged to obtain British permission before firing (22). How much conferring between nations can be done in six minutes or in the fog of war?

Nigel Calder provides several examples of communication problems in his book, *Nuclear Nightmares*.

"During the Middle Eastern war of 1967 the Israelis attacked an American spy ship, *Liberty*, which was lurking in sensitive waters. On the previous day Israel had asked the United States to move the ship out of the area, and the U.S. government had promptly agreed. Unfortunately no one told the ship. The Americans were not about to start a war with Israel over the incident, but it is easy to imagine a similar blunder in a crisis leading to graver consequences. Even the natural flurry of activity by U.S. Navy aircraft after the ship was hit was open to misreading by the Russians, so President Johnson used the hot line to explain what was happening" (23, p. 92).

During the Cuban Missile Crisis in 1962, a very dangerous situation arose. "A leading student of command and control, John Steinbruner of the Brookings Institution, points to a potentially fatal discrepancy between the president's intentions and what occurred at sea, where the U.S. Navy was intercepting and searching ships bound for Cuba. Naval officers, eager to perform their duty, interpreted their orders to include closing in on Soviet submarines in the Atlantic. Although the president and his commanders were

quite unaware of what the navy was doing, the Americans were unwittingly sending a very strong signal to the Russians that could be interpreted as a threat to attack an important part of the Soviet strategic forces - the missile-carrying submarines." (23, p. 92).

In 1971, Submarine Emergency Communication Transmitter Buoys twice accidentally signaled that U.S. nuclear missile submarines had been sunk by enemy action (24). If nations have little or no time to analyze the accuracy of such errors, how will they respond?

In total secrecy on March 1, 1982, the U.S. began a war game with the code-name, 'Ivy League', to test whether the President is able to communicate with his nuclear forces during an extended nuclear war. 'Ivy League' was the biggest command post exercise in 30 years. Its purpose was to evaluate plans and procedures associated with the Single Integrated Operational Plan (SIOP). The test covered a five day period (25).

Pringle and Arkin wrote a book entitled, *SIOP: Nuclear War From the Inside*. According to them, by playing Ivy League the military demonstrated that part of the command structure was vulnerable. In the war game, "the President was dead and the National Military Command Centre in the Pentagon was out of action. The Vice President had lived but his only surviving means of communication was a relatively precarious one -"a flying bunker" (25, p. 16). It was concluded, by the military, that the only way of insuring deterrence was spend a lot more money on C^3I. Will a lot more money solve the problems resulting from response time?

C. Communication Chaos Due To Electromagnetic Pulse

When a nuclear explosion occurs in space it produces an electromagnetic pulse (EMP) over a wide area. An EMP is an intense burst of energy that can travel across a continent at the speed of light and still pack enough punch to burn out electrical systems (26). A nuclear explosion on the ground also produces an electromagnetic pulse but for a much smaller area. Roughly 50 exotic effects can result from a nuclear blast, including many types of EMP, gamma radiation and X-rays, some of which are not fully understood.

EMPs exhibit a rise in voltage a hundred times as fast as lightning so that conventional electrical equipment is not protected against it. According to a Federal Emergency Management Agency study, the combined effects of blast and EMP could produce a nationwide blackout (27). Many crucial information bases, e.g. computer files, could be destroyed, or worse, rendered unknowingly inaccurate.

Wrestling with the EMP threat is a top U.S. priority. The U.S. has been grappling with the problem for many years and has currently earmarked large sums for this problem. Soviet manuals and magazines are rife with concern for EMP (26). Until the threat can be averted, it remains a serious "accidental-war-escalation" hazard.

If somewhere in the world a nation should launch missiles due to a false alarm, the resulting nuclear explosions could set off a series of EMPs. Many missiles are set for space bursts. A series of EMPs without a warning could disrupt communications and electrical power over a vast area of the world. In the ensuing confusion, would other nuclear nations launch their missiles at believed opponents, causing worldwide destruction or chaos?

The U.S. and U.S.S.R., even after spending large sums, will be able to protect only a small part of their defense installations and fewer civilian installations against EMP (26). What about those nations that do not have great sums to spend on communications and control? Chaos in their systems could trigger a war. As the number of small nations with nuclear weapons grows, the danger increases.

Former President Nixon said in an interview released October 2, 1983 "that he has 'nightmares' about Libyan leader Muammar al-Qaddafi obtaining a nuclear bomb and triggering a global war" (28). There may be good reason to worry. In April 1981, the West German firm of Otrag announced a fourth test of its low-cost single-stage launch vehicle from a site in Libya. Morrocco charged that Libya was using Otrag to acquire a capability to develop medium-range missiles. Lynn Hanold of NASA told *Science News*. "It is a fact that this company has basically said they'll launch any

customers who would pay them" (29, p. 301). Libya's efforts to obtain nuclear weapons are described in Chapter IV. C. If Libya or any nation triggers nuclear explosions at a high altitude it could disrupt communications over a vast area. Is the world ready to protect itself?

As if the EMP generated by ordinary nuclear explosions were not enough, scientists have developed even more powerful EMP bombs. Donald Latham, Deputy Assistant Secretary of Defense said "What the weapons designers have been able to do is design weapons which are efficient EMP producers. It will be a very different weapon than what was used in the Pacific tests and could generate very high levels, very efficiently, of EMP"(30). In a 1962 Pacific test, a nuclear explosion 248 miles up affected Honolula 800 miles away by putting out lights, popping circuit breakers, ringing burglar alarms and downing power lines (31).

No Civil Defense Warning

Communications are essential to civil defense. Daniel Stein in discussing EMP says, "The population has long been instructed that, in an emergency, their radios or television sets will be a source of information and instruction. But since most modern radios and television sets reiy on solid state electronics, they stand potentially vulnerable:(31). Most of the energy in the pulse is concentrated in the radio part of the spectrum so both transmitting and receiving stations will be disrupted.

"A booklet issued by the Civil Defense Preparedness Agency asserts that 'because of its wide coverage the electromagnetic pulse can influence the stability, security, and control of the entire electrical system'. Power lines readily pick up electromagnetic pulses, and the resulting current surge could damage equipment fed by these lines" (31).

In a nuclear attack a series of high-altitude bursts is likely, notes a report by the Defense Civil Preparedness Agency. This would produce a series of EMPs. "The sources of these bursts may range from an attacker's offensive missiles detonated explicitly to

produce EMP effects, to our own defensive missiles deployed to intercept offensive missiles. It seems reasonable, then, to expect dozens or perhaps hundreds of high-altitude defensive and offensive bursts spread out over a period of a few minutes or an hour" (29).

In the U.S. Department of Defense report *The Resurgence of Strategic Defense* (32, p. 31) and in *NATO Facts and Figures* (33, p. 204), the possibility that we may have no warning is noted. As the probability of an accidental war grows relocation plans become increasingly meaningless as many may never receive a warning.

Nobody In Charge

In the U.S. the president and his assistants have many airborne command posts from which they might fight a nuclear war. Yet the doomsday fleet might not survive EMPs because of difficulty in shielding key electrical systems (26).

Even if the president's "hardened" airborne command post got off the ground, its radio range could be sharply reduced because the satellites used to relay its messages could be out of action. Launch officers of Minuteman missiles and commanders of submarines, cut off from superiors by an EMP attack, might fire missiles of their own accord, unleashing an uncontrolled nuclear spasm. In the meantime similar chaos could be reigning in many other countries

The hotline between the U.S. and Soviet heads of government consist of 2 satellites plus a wire telegraph circuit as a back-up The hotline can be disrupted, because EMPs can interrupt satellite communications and cause power line current surges, disrupting radio and phone lines (26).

In case of mass destruction of leaders, how would succession occur in each nation? Will their replacements be trained, informed, mentally stable and able to control the military? Will any communications work?

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Chapter IV ACCIDENTS INVOLVING PEOPLE

A. National Leaders' Accidents and Illnesses*

Leaders and their key assistants who control nuclear weapons suffer accidents and sickness like everyone else. As the number of nations and leaders with control of nuclear weapons at their fingertips grows, the danger of accidental use or unintentional use increases.

The following actual situations illustrate the problem. They are examples of the danger and are not intended to reflect badly upon anyone. All of the people discussed either had primary comman and control over nuclear arsenals or were within the highest echelo of advisors. Their connection to overall command was direct and continuous.

The first leaders to be discussed will be leaders in the Unite States because there is more information on them. Then to show that the problem is not confined to the United States, critical situations in other nuclear powers will be described, e.g. U.S.S.R., Britain and France. How long will it take before a leadership crises triggers a war?

In the U.S., the National Command Authority (NCA) exercises control of the strategic forces. The NCA consists of the President and the Secretary of Defense, or their legally designated successors, should they be killed or disabled. Of these officials, only the President has the authority to order the firing of nuclear weapons, although he must have the consent of the Secretary of Defense and the Chairman of the Joint Chiefs of Staff.

The above description of the NCA indicates a group decision process. Such a process provides some security to prevent a

* Many of the ideas for developing this section, prior to 1970, were obtained from a report by Joel Larus, "Safing the Nukes: The Human Reliability Problem," Provisional Edition, Stockholm International Peace Research Institute, Sveavagen 166, 113 46 Stockholm, Sweden, August 1970.

person in the chain of command from doing something reckless. The French President says he has sole launch authority. What is the decision process for new nations obtaining nuclear weapons? Command chains could be irrelevant if there is an attack without warning, whether intentional or accidental. How much conferring can be done in a few minutes?

James Forrestal, U.S. Secretary of Defense, 1948-49.

Secretary Forrestal was responsible for reorganizing our military establishment and its nuclear weapons. Before becoming Secretary he held prominent positions, including Secretary of Navy for 3 years, and performed his public responsibilities with consumate skill. For a full year before he resigned he was mentally ill, suffering severe depression complicated by paranoia. He committed suicide 55 days after he resigned (1). This sad example illustrates how even those who are responsible for the highest trust can change greatly while in office.

Louis Johnson, U.S. Secretary of Defense, 1949-50.

Johnson served as Secretary for 18 months during the time the U.S. started to develop hydrogen bombs and was placing heavy reliance on its atomic monopoly. It was his assignment to direct the Pentagon during the period that the U.S. was becoming militarily involved in Korea. A year after his appointment, as Secretary, immediate colleagues began to realize he was mentally ill. Secretary of State Dean Acheson recounts in his book an incidence in which Secretary Johnson totally lost control and became violent in a meeting with a room full of people. Six months later the President asked him to resign. Acheson was convinced that Johnson was mentally ill and was not surprised when some years later he underwent a brain operation (2).

Richard Nixon, U.S. President, 1969-1974.

"As the impeachment process wore on and reports circulated about the President's potentially unstable temperament at the time, Schlesinger (Defense Secretary) took an extraordinary action: he sent out orders to the various communications centers in the nuclear chain of command to report back to him, Schlesinger, any 'unusual' orders from the President" (3). It was during this period that President Nixon boasted to a group of congressmen that, "I could

go into the next room, make a telephone call and in twenty-five minutes seventy million people will be dead" (3).

James Carter, U.S. President, 1977-1980.

In 1977 the National Security Council held a mock nuclear alert and the helicopter supposed to lift the President to safety arrived late and was nearly shot down by Secret Service agents when it made its 'surprise' appearance on the White House lawn (4). Since Washington, D.C. is within easy range of Soviet submarines, the mock alert was supposed to take the President to the Presidential command plane. The chief executive was not able to reach the plane within the prescribed time. President Carter was so appalled at the performance he ordered a study of evacuation plans. But the question remains: can the President get into any of the command posts in the time it would take a ballistic missile launched from a Soviet submarine to land on the White House? (5, p. 171).

Ronald Reagan, U.S. President, 1981 - .

Wherever he goes, the President is always followed by a man with a black bag containing the codes by which the chief executive can authorize the launch of nuclear weapons. "One of the most frightening aspects of the television coverage of the shooting of President Ronald Reagan at the Hilton Hotel in Washington was the sight of the man with the black bag running in one direction as the presidential limousine drove off in another" (6, p. 12). The confusion that followed, with Secretary of State Alexander Haig saying on television, "I am in control here" is not very reassuring, especially since command of the black bag goes next to the Secretary of Defense according to the National Command Authority and the Vice President succeeds the President according to the Constitution.

Anthony Eden, British Prime Minister, 1955-1957.

During the time Britian faced one of its most severe post-war political crisis, Prime Minister Eden became very ill. This was during a time when Britain had nuclear weapons. For five months prior to the 1956 invasion of Egypt by a joint British-French expeditionary force, Eden was practically living on Benzedrine. He was taking pills for a defective bile duct. At a time of high

crisis (Oct. 5 on) in a technical sense, he was in a state of acute intoxication from his illness (7). His health did not seem to have a decisive effect on events. Will we always be so fortunate?

Layrenti Beria, USSR, Minister of Interior 1939-1953.

"Among the areas under his direct supervision was every phase of nuclear development, both for peaceful and military purposes. In addition, he controlled all the public security forces of the country. Up to his death (execution) in 1953, therefore, Beria had unchallenged access to the atomic bomb supply of Russia plus a vast army of men ready to carry out his orders" (8, p. 63). The Soviet government is a closed society and it is difficult to obtain reliable information on their leaders personalities. Only with death or resignation do some of their problems become known. While Stalin's daughter, Svetlana Alliluyeva, violently hated Beria, it does not render unimportant what she says. She writes that he "was more treacherous, more practised in perfidy and cunning, more insolent and single-minded than my father ... The spell cast by this terrifying evil genius on my father was extremely powerful and it never failed to work" (9).

Joseph Stalin, Soviet Premier, 1924-1953.

Stalin's daughter, Svetlana, in recounting her life with her father concludes that by the end of 1948 "He saw enemies everywhere. It had reached the point of being pathological, of persecution mania, and it was all a result of being lonely and desolate" (9). Soviet Premier Nikita Krushchev at the 20th Congress of the Communist Party stated that Stalin "had completely lost consciousness of reality; he demonstrated his suspicion and haughtiness not only in relation to individuals in the USSR but in relation to whole parties and nations" (10).

Charles de Gaulle, President of France, 1958-1969.

"The tussle between President de Gaulle and his generals reached a murderous level during the retreat from Algeria" (11). The fourth French nuclear weapon test was in preparation when the "Revolt of the Generals" took place (12). The French scientists at the test site were apparently fearful for the security of their incipient nuclear explosive. They hurriedly detonated the device, which they did against the wishes of the military commander of the

test site, to forestall any possibility of its capture by dissident military forces (13).

Alain Poher, Interim President of France, April 1969.

"When General de Gaulle resigned as President of the Republic in April 1969, he and his senior aides left the Elysee Palace with what one newspaperman described as "all documents" relating to the detonating procedures for the warheads. For the four days that Alain Poher served as Interim President, he was unaware, either by design or inadvertance, of the steps he would have to initiate if a critical emergency arose" (8).

Lin Biao, China's Defense Minister, 1969-1971.

According to a book smuggled out of China, Chairman Mao Tse-tung had his Defense Minister killed in 1971. While details of the infighting are open to doubt, it is known there was fierce tension between Mao and Lin. As told in the book, Lin was willing to involve China in a border incident that could have triggered a major war. "With help from top military commanders, Lin planned to stage a Sino-Soviet border incident sufficiently serious to prompt Mao and Chou En-lai to move to a secret command center outside Peking. There Lin's forces would overcome Mao's elite 8341 guards and suffocate Mao and Chou with gas bombs. Lin would become the ruler of China" (14). Who was responsible for China's nuclear forces during this internal fighting? China exploded its first A-bomb in 1964 and proceeded quickly to the H-bomb.

Assessing Overall Danger

We have been fortunate that none of the leadership crises, so far, have triggered a war. In order to assess this danger for the future consider the following.

- As the number of nations with nuclear weapons increases, the chance of error grows. In addition some militant leaders, who can be considered saints or devils depending on the point of view, may increase danger. What will happen, for example, if Muammar Qaddafi of Libya, Ruhollah Khomeini of Iran or Fidel Castro of Cuba obtain nuclear weapons? Some may have them now. (See Proliferation Perils IV. C.).

- As the time allowed for decision making decreases, any illnesses and accidents among rulers become more critical.

- If a leadership crisis occurs at a time of great international tension the danger of misjudgment is obviously amplified.

Frequency of Leadership Crises

One way to estimate the frequency of predicaments among national leaders is as follows:

- Calculate the average number of years between leadership crises per country. For example, if the five leadership episodes just described for the United States were divided into the 37 years we have had nuclear weapons, that would be an average of 1 episode every 7 years.

- With six nations known to have nuclear devices, that could be an average of nearly a leadership crisis every year somewhere in the World now. The frequency will increase as the number of nations with nuclear weapons grows. More nations may have nuclear weapons' now (See section on Proliferation IV. C.).

This estimation procedure needs much refinement but it has the advantage of being readily understandable. It needs to be greatly refined, for example, as to the seriousness of the crises and more complete reporting of episodes. The Accidental War Assessment Center described in the Prevention Chapter could do such work.

B. Weapons Handlers Problems* Illustrating Danger**

* Many of the ideas for the first part of this section were taken from Lloyd Dumas' article on "Human fallibility and weapons"(15).

**The senior author was an armorer in World War II and has some understanding of weapon handlers' problems. One night while working in the wind and rain on top of a B-29 bomber I accidently fired twin machine guns. Fortunately no one was hurt. Our airfield was bombed and strafed repeatedly with no warning. Some of our men, under stress, suddenly started doing unpredictable things that made "no sense," such as running around in an air raid with hands in the air. Many events did not go as planned.

Nuclear weapons handlers are the most powerful and deadly warriors in human history. Under certain conditions or by accident they could kill several million people or trigger a war.

Despite the powerful weapon with which they work, weapons handlers are ordinary people who make mistakes and have problems like everyone else. In addition, the stress and strain of their tasks can add to the hazards. The following actual examples illustrate the diversity and complexity of the problem. The examples are for the U.S. armed forces because more information is available. There is no reason to believe the other nations are any better. The problems for other nations are discussed later under "Accidents Involving Weapons."

- On September 18, 1980 in Arkansas, a technician dropped a wrench socket that fell 70 feet and ruptured a Titan II missile's fuel tank. The rocket's fuel exploded "with sufficient force to lift and pulverize the 750-ton door" and leave a 250-foot diameter crater. Twenty-one people were injured and one died. The huge multi-megaton nuclear warhead atop the missile was hurled several hundred feet from the silo (16).

- "In March 1971, three men working with U.S. nuclear war plans, all with top security clearance, were arrested for possession of marijuana and LSD. The three airmen had been assigned to the computer section in which the war plans for all U.S. nuclear armed forces are maintained, at the top secret underground Strategic Air Command base near Omaha, Nebraska" (17).

- In August, 1969, an Air Force major was suspended after having allowed three men, described as having "dangerous psychiatric problems" to continue to guard nuclear weapons at a base near San Francisco. One of the guards was accused of going berserk with a loaded carbine while at the base. The major testified that although he had received unfavorable psychiatric reports on the three guards, he had not removed them because he was short of staff (18). How do other nations handle staff shortages?

- In the early 1970s, an Army code specialist said he was under the influence of marijuana sometimes when he worked with secret materials while stationed at a U.S. nuclear missile base in Germany. He said that missile soldiers sometimes were high when they attached nuclear warheads to the missiles and when making missiles operational (19).

- In May 1969 an American nuclear submarine undergoing repairs in San Francisco harbor was sunk causing $25-million in damage. Two crews were engaged to run off a series of calibration tests aboard the Guitarro. The ballast and stern tanks were not properly filled allowing massive flooding through a sonar dome opening. The dome had remained unsecured for the two months prior to the accident despite a daily safety inspection by qualified personnel (8). The submarine was a nuclear-powered attack (hunter-killer) submarine, not a ballistic missile submarine. Nevertheless, the incident illustrates how a serious accident can result from long-term carelessness.

- One weapon handler wrote a book, *The Technician*, based on his own experience. He said, "I'm not the only technician in the U.S. program that bailed out because of accidents, near-accidents, and the mental stress involved in atomic weapons work. On the bottom level, people are all too human, errors, and slip-ups are made all the time" (20).

- The danger is not restricted to nuclear weapons handlers. On Oct. 8, 1950, two U.S. F-80 fighter planes attacked the Soviet Union. During the Korean war, the planes strafed a Soviet airfield near Vladivostok. The hedgehopping attack was aginst an airfield 62 miles from the Korean border. The USSR vigorously protested the "provocative attack." The U.S. eventually said it was a mistake due to navigation error and poor judgement. This happened at a time when American hawks were urging full-scale war against communism (21).

- In May 1982, a Royal Air Force fighter pilot shot down another British plane over West Germany. He forgot his aircraft was carrying live Sidewinder missiles (22).

Scope of Danger

After reviewing many accidents, Lloyd Dumas,said, "We have created a world in which perfection is required if a disaster beyond history is to be permanently avoided. But in the world of human beings perfection is unachievable. The more weapons we deploy and the greater their geographic dispersion, the more people will be interacting with them. And the greater will be the likelihood of disaster resulting from human error" (15).

In the U.S. more than 100,000 individuals have access to nuclear weapons. Transporting, servicing and guarding these weapons is an enormous task. The military well understands the danger of an accidental nuclear war. Every year, by a special program, (Personnel Reliability Program) the Department of Defense screens about 5,000 individuals for admission to these critical positions. They are screened out for a variety of reasons, e.g. alcohol or drug abuse, delinquent or aberrant behavior (23).

Despite great care in screening for reliable people, dangers can still arise. For example, serving aboard a submarine continuously on patrol for long periods, in a very boring and unchanging routine, can generate inner tensions, aggravate people and cause sleeping difficulties. In a one year study (1965) of 2,600 men assigned to operating nuclear submarines, 1 percent were referred for psychiatric consultation (24).

The Group for the Advancement of Psychiatry reports that the "incidence of psychosis in the armed forces of all nations that have kept statistics is about 3 per 1,000 per year in peace and war" (25). A 1972 study by the Department of Defense projected daily drug use as high as 8 percent for some categories of drugs (26). While the above figures apply to all servicemen, the earlier examples show that those who handle nuclear weapons also share these problems.

Much to the armed services credit they have been concerned about nuclear accidents for a long time. Out of this concern for weapons safety, engineers developed intricate switches, exotic locking devices and other safeguards. The U.S. ultimately perfected the Permissive Action Link system (PAL) to prevent

unauthorized use of nuclear devices on which it is installed (8). PAL makes it impossible for anyone to detonate the warhead without a specific electronics or mechanical input from the president. Former Secretary of Defense Robert McNamara in December 1983 said, "We should endeavor to obtain agreement of the Soviets to apply similar devices to their warheads" (27).

The bulk of America's tactical nuclear weapons consists of rockets, artillery shells and land mines. The development and distribution of thousands of these tactical weapons means that there is devastating firepower in the hands of company-size units. Furthermore, some of the Army's tactical systems are under bi-national control, mostly in NATO countries. All of these factors make for potential sources of human failure (8).

How little or much authority to allow handlers over the use of nuclear weapons poses a dangerous dilemma for all nations. Consider, that in a time of very great tension, it may be necessary to allow officers greater authority over the decision when to fire, especially if communications are disrupted. However, the more people are allowed authority, the greater the chance for error, especially in a time of great stress and poor communications.

Using the U.S. experience as a guide, it can be readily seen that vast numbers of people now handle nuclear weapons in the World. As the number of nuclear powers grows, the problems will increase.

There are many questions about weapons handlers' safety that need to be answered. What type of safety systems do other nations have? If command bunker screens go haywire due to electrical or magnetic interference, will such safety devices as PAL work? Can we always be sure that individual handling of nuclear weapons will be adequate?

C. Proliferation Perils

Knowledge Spread

As the number of nations with nuclear weapons increases, the number of ways that nuclear weapons can be fired on purpose or by

accident grows. There are 26 nations that have nuclear weapons or are capable of making them. The five nations that are known to have nuclear weapons are the U.S., U.S.S.R., Britain, France, and China. India has exploded a nuclear device. In addition, as many as 20 other nations are technically capable of making nuclear weapons, according to the *Nuclear Proliferation Factbook* (28). Appendix B provides details.

Whether nations capable of making nuclear weapons make them or not is a political decision. Just because a nation has not exploded a nulcear bomb does not mean they have not made any. Some nations may have nuclear weapons without manufacturing them. Libya is reported to have five atom bombs although it is not on the list of nations technically capable of making them. She is reported to have received them from Pakistan for $100 million investment (29). The story that Libya has atomic bombs could not be confirmed, however, it does show their efforts to obtain them.

Stopping the spread of nuclear weapons is a difficult task. The following examples illustrate the problem.

- To design a nuclear bomb, nobody has to start from scratch anymore. Dmitri Rotow, a Harvard economics student, drew up blueprints for a bomb and put them out to machine shops for estimates. The total bid for all the components was $1,900.00. "Even for the more complicated fusion weapon, Rotow found everything he needed to know about designing an H-bomb in the Library of Congress in Washington. He wrote a book about it in 1978 but his design was so close to the mark that the Department of Energy classified it as secret. An unofficial group could produce a fusion weapon only if it was very well organized, although any nation-state could do so" (11, p. 64).

- Pakistan illustrates one nations efforts to obtain nuclear weapons. Canada provided Pakistan's one and only power reactor. "But when Pakistan acquired a pilot reprocessing plant from Belgium and then announced plans for a full-scale plant to be built by the French, Canada demanded stricter safeguards on the power reactor. Pakistan refused; Canada cut off supplies

of spares and fuel and cancelled all further dealings. In due course, France belatedly pulled out of the contract to build the Chasma reprocessing plant, leaving it unfinished. But international relief was shortlived, for in 1978 it was revealed that Pakistan was constructing a secret enrichment plant, using technology stolen from the British-Dutch-West German consortium URENCO. Much of the plant's hardware was purchased in Western Europe by "dummy companies" acting for Pakistan" (30).

. Argentina, while building a nuclear plant for energy, is probably preparing a base for developing weapons. Argentina awarded a contract for a nuclear energy plant to a German-Swiss group, despite the group's bid being $500 million higher than the bid of a Canadian group. The higher bidder did not require full anti-weapon safeguards. Argentina has always refused to sign the Non-Proliferation Treaty and is on record as reserving the right to acquire nuclear weapons (30). When Argentina has nuclear weapons, how will issues like the Falkland Islands be handled?*

. Middle East proliferation raises the possibility of a nuclear war. "Israel has the bomb, or so almost every expert now believes, and Israel suspects that other countries in the area are interested in acquiring it. In April 1979, at LaSayne near Marseilles, in France, large research reactors under construction for Iraq were blown up with plastic explosive, in what was generally assumed to be the work of the Israeli secret service" (11). On June 9, 1981 Israeli planes bombed an Iraq nuclear reactor. There was a vigorous international protest (31). If Iraq should eventually develop nuclear weapons it may affect not only Israel but also the Iran-Iraq war, thus keeping the chain reaction going. The technological base exists in Iran for reviving a moderate nuclear weapons program which could include bomb making (11).

*The above assessment of Pakistanian and Argentinian efforts to obtain nuclear weapons was made by Walter Patterson, editorial advisor for the *Bulletin of the Atomic Scientists*. In making these assessments he cites as his source the World Information Service on Energy (WISE). Patterson points out that while many of WISE's references are from official sources, not all are. Some of the unofficial sources are important because they offer evidence not otherwise availabe.

Materials Spread

There are many ways in which determined nations can obtain materials for nuclear weapons. Two broad avenues to this end are to produce plutonium or highly enriched uranium directly or to divert weapons-usable materials from the civil nuclear fuel cycle.

"Since 1954, the United States has exported more than 16,000 kilograms of highly enriched uranium for use in research and test reactors in 43 countries" (32). It only takes about 25 kilograms of such uranium to make a nuclear explosive device. According to the U.S. General Accounting Office, the monitoring system for keeping track of all weapon-grade uranium exported by the U.S. is incomplete and inaccurate (32).

On an international basis control of weapons-grade nuclear materials has many problems. For example, the International Atomic Energy Agency (IAEA) has been able to carry out only 50 percent of its routine inspections. Any nation can veto any inspection of its nuclear facilities. Some research reactors are visited less than once a year. The seriousness of this lack can be seen, when it is realized that it only takes 7 to 10 days to convert some materials to nuclear explosive devices (32).

"Looking beyond the current batch of 'proliferating' nations, the prospects for preventing still more from obtaining the bomb are poor unless a great change of heart occurs in the world. There is cause for concern about the increasing quantity of plutonium that will be in circulation when current plans for civilian nuclear power come to fruition. One reason for the increase is the growing number of nuclear reactors of present types, which convert natural or partly enriched uranium into plutonium. Another is the advent of the new generation of reactors, the so-called 'fast breeders,' which will burn the plutonium "and thereby get rid of it" but in the process will 'breed' yet more fissionable fuel-plutonium or uranium-233. The plutonium produced in the breeding process can easily be of weapons grade. The opportunities for diverting the nuclear explosive from civil to military uses may simply outstrip even the most determined efforts at applying safeguards" (11).

Proliferation Safeguards

We cannot stop the spread of knowledge, but agreements for verifiable control can stop the need for building nuclear weapons. Since many nations do not want to build nuclear weapons but are worried that their neighbors might, agreements that are verifiable are crucial. When adequately verifiable agreements are made, it will provide far greater security at far less cost than competing in the building of nuclear weapons. More effective international control is needed than the International Atomic Energy Agency currently provides.

D. Escalation of Small War

The Center for Defense Information is a think tank in Washington, D.C. that, among other things, continuously monitors conflicts around the globe. The following observations from their work illustrates the increasing probability of a global war starting unintentionally through small wars.

- "World War III could grow out of 'local' war. Numerous conventional and guerrilla conflicts have the potential for regional expansion and superpower confrontation" (33). In many of the conflicts the U.S. tends to support one side and the Soviet Union the other.

- "Over the past three years (as of 1983), conflict, violence and international tensions have increased in nearly every region of the world. Six new wars have started while only two have ended. Many continuing conflicts have escalated dramatically" (33).

- "Today there are approximately 40 major and minor conflicts in the world, involving 45 of the world's 164 nations" (33).

- There is a tendency to forget some of these conflicts throughout the world. For example, the Korean War has never officially ended. There are frequent reports of gun fire. "The United States has 39,000 combat troops stationed in South Korea. Those troops are armed with America's best weapons and have nuclear capabilities" (33).

"Four nations sell 90 percent of the arms: the United States, the U.S.S.R, the United Kingdom, and France. Inevitably they give tacit political support to their customers, but the involvement goes further than that. Training programs and the provision of official mercenaries - technicians and advisers - make the sales hard to distinguish from military alliances. Most serious of all, in time of war the customers make urgent demands for spare parts, replacements, and reinforcements. The supplier must either let his customer lose the war or send his own ships and air transports into the war zone" (11).

Since the major powers are the main supplier of arms, they can do something to reduce the hazard of small wars expanding into a world conflict. They need to be cooperating for their mutual security rather than competing. This is especially true, as the following factors are making local conflicts increasingly dangerous.

- Conventional weapons are becoming vastly more powerful and can greatly expand the intensity of local conflicts. This is discussed more fully in the next chapter on Accidents Involving Weapons.

- An increasing number of nations are becoming capable of building their own nuclear weapons.

E. How Terrorists Could Trigger A Nuclear War

There has been much concern about terrorists obtaining nuclear weapons. They could cause great panic by destroying a city, dam or nuclear power plant. Nuclear terrorists could threaten a vast area by choosing not to identify themselves, their location or their target. Despite the many types of catastrophies that are possible and have been widely discussed, little attention has been given to the most awesome peril of all. Consider the following danger, one that is preventable.

A terrorist group could precipitate a nuclear exchange between two nations. An exchange could be ignited because there is no existing worldwide framework for quickly and decisively determining the origin of an exploding nuclear weapon or if it was authorized (34). Once an exchange has been started it would be difficult

to limit. This problem is compounded by the decreasing time for error correction and the increasing number of nations with nuclear weapons. Terrorism, according to the U.S. Department of Justice is "the calculated use of violence to obtain political goals through instilling fear, intimidation or coercion" (35).

How Terrorists Can Obtain Nuclear Weapons

As the number of nations with nuclear weapons increases, the routes by which terrorists could obtain nuclear weapons will expand. Consider the following scenarios, some of which may have already occurred (36).

- A sympathetic government could give weapons secretly to a group aiding them in a difficult war.
- National leaders could trade nuclear weapons for desired tasks.
- Revolutionaries could take possession of stockpiled weapons as a result of a coup.
- Terrorists could steal weapons-grade materials from reprocessing facilities with inadequate safeguards. IAEA safeguards are inadequate.

Another way terrorists might obtain control of nuclear weapons is through computer-based technology. Officials are particularly worried about the computer security of nuclear reactors, nuclear weapons and targeting information (37).

Theft of plutonium is a problem, since even before 1975 it was worth $5,000 per pound. While security is tight, still plutonium makes a very tempting target, as more nuclear plants are being built throughout the world (36, p. 98).

How many nuclear weapons sites in the world are vulnerable to terrorist attack? U.S. Congressman Clarence Long, after a six months investigation, cited such problems as: equipment in restricted areas suitable for carrying away nuclear weapons, weapons stored in the open, and superficial security checks (39).

Each day men and women are receiving extensive training in nuclear explosives from industry and the armed services throughout the world. They are learning all aspects in the assembly and wirin process as well as detonating procedures. The number of such peopl is growing. In fact, IAEA has formal training programs, even for technicians of countries that have not signed its Non-Proliferation Treaty.

While most persons do not abuse this knowledge after leaving employment, what about those who might? They are scattered all over the world.

Amount of Terrorist Activity

There have been many more terrorist acts committed against nuclear facilities than is generally realized. The following examples illustrate the problem.

- "In the United States, between April 1969 and July 1976, there were 235 threats of violence or acts of violence toward nuclear facilities--" (36).

- In America and Western Europe from 1975 through 1979, there were 27 attacks or physical security breaches at nuclear facilities, an average of 3 per year (32).

If all terrorist acts (nonnuclear and nuclear) are considered, there is far greater terrorist activity than indicated above. The following data illustrates how frequent terrorists' acts can be.

- Italy was struck 428 times in eight months in 1982 by terrorists of left and right (40).

- In a 30-day period, in the summer of 1982, France suffered 112 incidents. Many bombings were by Corsican autonomists (40).

Nations have procedures for trying to protect themselves against terrorists' activities. For example, the United States has a special team called Nuclear Emergency Search Team (NEST) for finding and disarming terrorists' nuclear weapons (41). So far in investigations they have found no nuclear weapons. At best, their

response time is two hours. Is this adequate?

If the world's economy becomes more depressed it can stimulate revolutions and terrorist activity. How many of the nations with nuclear power plants or weapons have special teams for finding and disarming terrorists' nuclear weapons?

The U.S. is trying to work out in advance procedures for dealing with the contingency of some terrorist group getting a nuclear device. The U.S. has proposed that multi-lateral agreements be made to handle these emergencies. Discussions on this measure was opened between the Soviet Union and the U.S. in August 1983 (42).

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Chapter V. ACCIDENTS INVOLVING WEAPONS

A. New Weapons Are Increasing First Strike Edginess

First Strike Syndrome

The possibility that some nation will launch a nuclear first strike is growing. Consider the following reasons as applied to the U.S. and U.S.S.R. and then as they apply to other nations.

- Nations are being driven to giving increasing consideration to the advantage of striking first in a nuclear war. As weapons grow more accurate and deadly, each side is becoming more afraid that the other side will obtain an overwhelming advantage. The ultimate dread is that an attacking nation could destroy the other side so quickly and completely that it would have little opportunity to retaliate, leaving the attacking nation with damage they consider "acceptable." The "acceptable" damage however, could amount to millions of deaths to one's own side. This does include vast clouds of radioactive dust and many other environmental and weather hazards created by one's own bombs.

- At this time, neither the U.S. nor U.S.S.R. can now stop a devastating retaliatory response. However, as the ability of nations to overwhelm each other grows, the urgency to strike before they are overwhelmed increases. To complicate matters further, it is difficult to tell when one side or the other may have an overwhelming first strike ability. It is just possible, therefore, that a nation may strike first if they just think their opponent is getting an advantage. The peril is further aggravated by each side's tendency to emphasize the opponents' strength to justify their own defense buildup.

- Another first strike advantage is that the "defensive" costs are astronomical compared with "offensive" costs. The cost of nuclear warheads is small while the cost of missile interception, silo defense and limitation of casualties are prohibitive. Having many warheads on each missile increased capacity to devastate a large portion of the opponents' missile forces

while still holding a sizeable number of missiles in reserve. Also defense weapons can aid in a first strike.

- As nations' power grows, each opponent becomes increasingly fearful, distrustful and crisis prone (e.g. Korean Airliner disaster) thereby increasing first strike edginess.

- As warning time decreases, the time allowed for deciding who should seize the first strike advantage in a growing crisis may be only minutes. How many crises will occur before some nation goes nuclear?

- As the number of nations with nuclear weapons and the ability to deliver them grows, other nations will get caught up in the first strike syndrome, e.g. Middle East and South American countries. Since it would take fewer weapons to destroy a small nation's defenses, small countries could be far more edgy, especially those invaded recently.

- A first strike by any nation against another may go global. A nuclear war anyplace on earth could create communication and transportation chaos over a large area (e.g. electromagnetic pulse blackout, radioactive dust). The ensuing confusion could cause other nations to believe they are under attack thus escalating the war.

While many people are keenly aware of the increasing possibility of a first strike war, probably most do not understand this complex problem. The more clearly the social and psychological processes at work are understood, the easier it should be to break out of the cycle of fear that drives the arms race.

Since no nation alone can stop the arms race, the first strike syndrome needs to be understood worldwide. Herein lies a great challenge. Can this complex danger be made readily understandable to humanity? The more simply and forcefully the danger can be communicated, the greater should be the concern and efforts of all for prevention.

First Strike Self-Destruction

It is possible that a first strike by either the U.S. or the U.S.S.R. could mean the extinction of the human species even if the other side never launched a missile. Carl Sagan in his article, "The Nuclear Winter" describes how a war detonating 5,000 megatons could cover much of the earth with ice for months. There are more than 13,000 megatons in the arsenals of the U.S. and the Soviet Union. Sagan and his associates considered a war in which a mere 100 megatons were exploded, less than one percent of the world's arsenal. Their computer model analysis found a 100 megaton attack on cities could generate an epoch of cold and dark almost as severe as a 5,000 megaton attack (1).

In a scientific conference, in Washington, D.C. in November 1983, 100 scientists addressed what climate changes might be wrought by a nuclear war. The conference was the outgrowth of two years of study. These scientists' findings were supportive of Sagan's observations (2). The Nuclear Winter hypothesis has been confirmed by independent studies conducted by Soviet atmospheric scientists and two such scientists at the Lawrence Livermore National Laboratory. Could a small nation launching a 100 megaton attack on a neighbor turn our earth into a cold and dark planet? What is being done to prevent such a catastrophe?

First Strike Potential

In order to better understand how new weapons can create first strike anxieties, let us consider weapons systems of the U.S. and the U.S.S.R. that are being developed. Individually weapons systems may not present first strike threat but collectively they could.

Trident-1 and Minuteman-3

The U.S. is building a fleet of Trident submarines. By 1988 Trident-1 accuracy-improved weapons in conjunction with Minuteman-3 upgrades will have the ability, in theory, to destroy almost every nuclear weapon on Soviet soil (3).

Does anyone imagine the Soviets will wait five years until they have no options? Are we not forcing them to attempt a first strike, even at hideous losses to themselves and the world?

In five years (from 1983), by the time Navstar is fully operational, there will be enough Trident submarines and Trident-1 missiles to send two warheads to each Soviet silo. With the kind of exactness provided by these satellites it can be expected that 1,146 of the total 1,398 Soviet silos would be demolished. Nuclear detection sensors, which the Pentagon is installing on many different spacecraft in an assortment of orbits, will very quickly tell the War Room in Washington which silos escaped destruction so a second wave of 64 missiles could be dispatched. This would wipe out all but 49 of the remaining ICBMs. But even if that second wave were unsuccessful because of the fratricide effect, or because the Russian ICBMs were already launched, the ballistic missile defense (BMD) being developed at Kwajalein Atoll in the Pacific would be ample to intercept Soviet retaliatory missiles (3).

"...Trident is shaping up to be a very lethal weapon. A few years ago Norman Cousins pointed out in a *Saturday Review* editorial (4) that, next to the leaders of the Soviet Union and the United States, a Trident submarine commander is the third most powerful man in the world. He controls more destructive power than the military establishments of Britain, Italy, Spain, Brazil, Argentina, West Germany, Japan, the Philippines, India and Pakistan all put together" (5, p. 99).

Former President Carter spoke of how the Trident-2 could increase first strike anxieties. "...the potential impact of the Trident-2 missile on strategic stability is less clear and may be negative, due to the significant hard target kill capability it may have...this hard target capability could stimulate negative effects on Soviet reactions, which, in turn, could lead to instabilities in the strategic balance and complicate future strategic arms limitation efforts. ...the Trident-2 SLBM...also could be perceived as a first strike weapon with a significant hard target kill potential against time-urgent targets... ...Leonid Brezhnev has... announced that if the United States continues to deploy Trident, the Soviets will deploy a comparable system, Typhoon..." (6, p. 40).

Other New U.S. Weapons

Another new weapon that adds to first strike anxieties is the MX missile. One hundred MX missiles are planned for 1989 (3). Former President Carter's words clearly describe the danger when talking about 200 MX missiles.

"...With the MX deployed in substantial numbers, in addition to Minuteman, the US would have acquired a capability to destroy most of the Soviet silo-based ICBM force in a first strike. Such a prospect could be of considerable concern to Soviet leaders since a significantly greater percentage of Soviet strategic weapons (about 75 percent for the USSR versus about 25 percent for US) is in its ICBM force, despite the fact that some (deleted) percent of the Soviets' deployed strategic weapons could survive" (7, p. 65).

"...under extreme crisis conditions, Soviet leaders, concerned that war was imminent, and fearing for the survivability of their ICBMs if the United States struck first, nonetheless might perceive pressures to strike first themselves. Such a situation, of course, would be unstable" (6, p. 21).

Serious as the Trident and the MX are as first strike weapons, the danger is greatly compounded because they are only two of many new weapons. Other new U.S. weapons are the Pershing 2 and cruise missiles discussed in Chapter II. There are also neutron bombs and biochemical weapons.

Greater accuracy of weapons also makes them much more deadly. For example, the Department of Defense plans to purchase 17,322 war terminals for Navstar global positioning system (GPS) to make weapons much more accurate (8, pp. 337&398). Combined, the new weapons and their greater accuracy increase the U.S.'s ability to overwhelm the Soviets, thereby greatly increasing their first strike edginess.

The main point in these improvements in the U.S. weapons systems could cause the Soviet Union to think that the U.S. will have a first strike capability by 1988. Such a situation can be extremely dangerous, when Soviet leaders may have to decide within

a few minutes in a future crisis whether to seize the supposed first strike advantage or not.

Soviets' New Weapons Add To Anxieties

From the U.S. and its allies' point of view, the growth of the Soviet military machine is equally provocative. The Soviets are adding many new weapons to their already massive arsenal, in addition to a force that numbers nearly 5 million men. The following statements from the U.S. Department of Defense illustrate this growing threat (9, p. 3).

- "The first of the USSR's 25,000-ton TYPHOON-Class strategic ballistic missile submarines has test fired its MIRVed, nuclear-warhead, 8,300-kilometer-range, submarine-launched ballistic missiles. A second TYPHOON has been launched."

- "More than 330 mobile launchers for the SS-20--a Longer-Range Intermediate-Range Nuclear Force (LRINF) missile with three nuclear warheads and reloads for each launcher--are now arrayed against Western Europe, the Middle East, parts of Africa, and most of Asia, including China and Japan."

- "Five Soviet shipyards have continued to produce new attack submarines for the world's largest submarine force. In 1980, the first of the new, extremely large OSCAR-Class guided missile submarines was launched, a submarine capable of firing up to 24 long-range antiship cruise missiles while submerged. That lead unit is now on sea trials, and a second unit has been launched."

The above is a listing of only some of many new weapons being developed by the Soviets. Again, the more and deadly the new weapons are which each nation can deploy the greater the opportunity for an overwhelming first strike.

Perception Of Power (10)

A key concept in the first strike syndrome is the perception of the power of weapons. During the past two decades, a dangerous divorce has taken place between the physical realities of nuclear

weapons and the perception of such weapons as a source of power. This role reversal, from physical carrier of destruction to political tool, has made difficult any rational assessment of the adequacy of a nation's nuclear weapon supply.

This role reversal amplifies the arms race. That is, non-scientific (political) factors overshadow technical or military factors as the reasons for arms buildup. Consider the following factors that fuel the arms race.

1. There are strong institutional pressures to increase the arms buildup by the military sector, which comprises a large part of each nation's economy. This is true for capitalist and socialist countries alike: any producer can give dozens of reasons why more of his product is needed.

2. We are always seeking an advantage. New technologies--such as the MX, particle beam and laser weapons to name a few--are especially sensitive to this pressure. The political prestige of a perceived breakthrough is difficult to forgo, even if the military significance is doubtful. Of course the other side wants this advantage too, fueling another round of arms buildup.

3. Difficulty in assessing military power increases fear. Both the U.S. and U.S.S.R. claim the other side has achieved superiority. Obviously, both cannot be right. There is a tendency to engage in simplistic number manipulation, while publicly ignoring hard to quantify factors such as the reliability of allies, differences in geography, length of boundaries shared with potential adversaries, etc... Especially at defense budget appropriations time, the simplistic political perception far outweighs objective reality.

Appendix C provides a Briefing Paper on "Balance Of Forces". This summary, based upon the work of the International Institute for Strategic Studies and published by the Union of Concerned Scientists, shows the U.S. and Soviet nuclear arsenals to be roughly equal.

4. The secrecy of military planning in itself causes fear and thus fuels the arms race, besides hurting the feasibility of verifying any arms control agreement.

5. It is difficult to predict sufficiency of weapons actually needed in a nuclear conflict because of both sides' unwillingness to admit targets.

6. Momentum can impede arms control. When a military system proves a useful bargaining chip, it becomes politically difficult to drop it after negotiations are completed.

The Soviets have pledged a no-first-use, and knowledgeable persons in the U.S. have also urged a no-first-use doctrine (11). While the idea has great appeal, it probably has little value.

Even as we pledge not to strike first, we obviously go on developing a first-strike-capability and vice versa. Who would have confidence, therefore, in a pledge that could disappear in seconds? Actions speak louder than words. Verifiable arms reduction agreements are urgently needed.

In summary, nuclear weapons have come to primarily serve a political purpose since their use could bring humanity's extinction. As both sides become increasingly aware of nuclear weapons' total destructiveness, their use becomes increasingly unlikely except through accident.

B. Nuclear Weapons Accidents

Overview

The introduction to one U.S. - Soviet treaty reads as follows. "Despite the most elaborate precautions, it is conceivable that technical malfunctions or human failure, a misinterpreted incident or unauthorized action, could trigger a nuclear disaster or nuclear war" (12 p. 10).

There are 50,000 nuclear weapons in the world (13 p. 12). Since these weapons are in various stages of development and deploy-

ment it can be expected that accidents will happen.

Accidents are more frequent than generally realized. Milton Leitenberg, for the Stockholm International Peace Research Institute, has made the most comprehensive studies of nuclear weapons accidents known. More than 100 nuclear weapons accidents and incidents* were reported in the world up to 1976 (14 p. 65-82).

Many more weapon accidents have occurred than have been reported. The U.S. restricts public information unless such disclosure is forced by the circumstances. The U.S.S.R., France, Britain and China follow policies of not reporting such accidents unless forced. There are more accidents known for the U.S. than any other country. This probably results from the U.S. having more weapons and a more open reporting system.

On an average nuclear weapons accidents are more frequent than generally realized. "Assuming that there were few or no accidents before 1950, this suggests that there have been about 125 nuclear weapon accidents, major and minor combined, between 1945 and 1976, or about one every two and a half months" (14 p. 52). This is a very conservative estimate as it is only for known accidents and does not include incidents.

While our main concern is the prevention of an accidental war, it is important to note that even one weapons accident can be very dangerous. In 1979, the U.S. General Accounting Office asked the Lawrence Livermore nuclear-weapons-research laboratory to develop a scenario that would provide a reasonable estimate of the consequences of a nuclear-weapons accident.

A typical nuclear weapon contains more than 4 pounds of plutonium. Inhaling 1 millionth of a gram can cause lung cancer. "The laboratory calculated that a weapons accident could create a radioactive cigar-shaped cloud of plutonium extending from the accident scene for about 23 miles, with a maximum width of about 2½ miles" (15). This is an area equal, for example, to the major

* An incident is an unexpected event that involves damage to nuclear materials but is less serious than an accident.

population corridors along Puget Sound. Nuclear weapons are handled at McChord and Bangor, Washington.

The U.S. Department of Defense, in a letter to the authors, describe extensive safety features they have to prevent an accidental nuclear explosion. They have instituted four positive safety measures. Many measures are used for storage safety and to prevent deliberate or inadvertent use except when directed by competent authority (16). We hope other nations have as extensive safety measures.

Some accidents are much more dangerous than others. For example, accidents at launch facilities or transport vehicles are not likely to start a war, unless of course, it is viewed as an attack. Such a mistake is more likely in Third World countries, where emergency communications systems are poor.

Examples Of Accidents

While the danger of weapon accidents is world-wide, four recent examples from a local newspaper help illustrate the problem.

- On November 29, 1982, a B-52 bomber exploded and burned on the flight line at Merced, California. The nine crew members were evacuated safely (17).
- On December 16, 1982, a B-52 crashed near Sacramento, California. All nine crew members were killed (18).
- On January 27, 1983, a B-52 parked on a maintenance ramp in Grand Fork, North Dakota, exploded killing five maintenance workers and injuring eight other people (19).
- On April 11, 1983 a B-52 flew into a mountainside near St. George, Utah killing the crew of seven (20).

Nuclear Explosion Possibilities

The world's safety record has been good. Despite many weapons accidents, there have been no accidental nuclear explosions. This

does not mean, however, that there never will be any.

On January 23, 1961 near Goldsboro, North Carolina, a B-52 bomber carrying two 24 megaton bombs crashed. On one of the bombs, five of the six interlocking safety mechanisms were activated (21 p. 127). A 24 megaton bomb is nearly two thousands (1,920) times more powerful than the Hiroshima bomb. How much different would history be if the single remaining switch had not prevented an explosion?

Weapons accidents could become more dangerous in the future for the following reasons.

- Most accidents occurred during transportation. With the trend toward mobile weapons we can expect an upswing in accidents.
- Shorter response time puts more strain on human operators and equipment to respond correctly when an accident occurs, especially if accident occurs in a battle zone.
- As more nations acquire nuclear weapons, safety standards will be lowered by those with more limited funds for weapons development.

How Weapons Accidents Can Trigger A War

Could an accident trigger an accidental war? Consider the following possibilities.

- An accident could cause a period of confusion that could be interpreted as an enemy attack. For example, it took nearly six months to determine that the sinking of the U.S. nuclear attack submarine "Scorpion" in the Atlantic during May 1968 was not the result of foul play (22 p. 71). How could this be interpreted during a time of crisis?
- An accidental nuclear explosion might precipitate a nuclear exchange between nations because there is no procedure for quickly determining the origin of an explosion.

How long will it be before we have one too many dangerous incidents or accidents?

C. Unreliability of Weapons

Lack of Weapons' Reliability Could Trigger A War

A nuclear missile, or a conventional missile interpreted to be nuclear, can unexpectedly fly over or crash into the territory of another nation. The following examples illustrate how dangerous such unreliability can be.

- In 1960 a Matador missile, after an aberrant flight toward mainland China, crashed into the Straits of Taiwan (23).
- In 1967, there was an overflight of Cuba by a U.S. Mace missile (24).
- It was reported in 1960 that Nikita Khruschev told Vice President Richard Nixon about an erratic Soviet missile that was destroyed as it headed toward Alaska (25).
- In the late 1960s, a Poseidon test reentry vehicle flown on an Agena rocket from Green River, Wyoming overshot the White Sands Missile Range and landed in Mexico.
- In 1983 a Navy guided missile frigate, USS George Philip, fired a shell toward a Mexican merchant ship (26).

The number of components in weapons systems that can error is far more than most people realize. In Appendix D is a long technological listing of possible error areas. As the number of nations with nuclear weapons increases, the opportunities for unreliable weapons to cause a dangerous international incident grow. This danger may be especially serious for small countries that need large distances for testing missiles.

Future Uncertainty of Weapons

Understanding why some weapons are unreliable is important

because such understanding shows how weapons accidents can continue to happen and maybe even more likely to happen in the future. Control over weapons can be uncertain for many reasons. The following examples illustrate this (27).

. Materials used can be strongly noncompatible.
The conventional high-explosive compounds used to set off the nuclear reactions are chemically unstable, and the nuclear materials constantly give off radiation, which can degrade metallic switches, bonding glues and other key parts inside the closely packed warhead container. A typical modern warhead may have as many as 2,000 parts, any one of which could foul up proper detonation.

. Growing technical complexity increases chance of malfunction.
- launch electronics
- timing stage separations
- disturbances in the guidance systems
- elaborate tricky fuses

. Outside factors can affect weapons
An electromagnetic pulse, rain, snow or gravitational anomalies can all disturb a missile's trajectory, causing it to land off target.

. Aging can cause parts to deteriorate.
In a typical military integrated circuit or hybrid chip, gold wires are bonded to aluminum on the chip substrate. After three years at room temperature, the two metals will form a brittle "intermetallic" connection that may snap under stress.

Examples of Weapons Failures

Unreliability of weapons is more common than is generally realized. Consider the following examples.

. The Soviets are concerned about the reliability of the liquid fuel in their missiles. "Liquid fuel rockets are subject to corrosion, chemical instabilities and explosions, and vastly greater handling and maintenance problems. Upward of one third

of their entire missile force is down at any time for scheduled maintenance. Only 15 percent of their nuclear submarines are ever at sea; they too carry volatile liquid-fuel missiles at enormous peril to their crews" (27). The Soviets, recognizing the impracticality of liquid-fuel motors, have long tried, unsuccessfully to date, to perfect solid-fuel technology. How many of this type of missiles are being exported to other countries?

. In September 1983, a Soviet rocket exploded on the launch pad as it prepared to boost three cosmonauts into space. The booster rocket failed when 270 tons of kerosene and liquid oxygen exploded (28).

. The Minuteman, a major U.S. missile, has only been tested four times from operational silos. Of the four attempts made between 1966 and 1968, not a single one worked. Even from Vandenberg test facility, where missiles can be fine-tuned before a launch, the rockets don't always work. For example, in March 1982, the first Minuteman 2 to be tested in two years blew up over the Pacific Ocean. It had internal failure of the second stage during the burn (27).

. The Pershing 2 has had many failures (29).
- "Early tests of the Pershing 2 concept took place in 1977-78, using a modified Pershing 1A. Four of five tests were failures; a sixth was cancelled".
- On July 22, 1982 the first Pershing 2 prototype lifted off Cape Canaveral and exploded. The high-energy propellent had burned through the lightweight motor case designed to gain range. This is the same problem that plagued the Trident 1 test program.
- A second prototype test of Pershing 2, at White Sands, flew 75 miles and missed its target by 4 miles. This happened even with aluminum reflectors to guide its warhead, a maneuvering re-entry vehicle (MARV).
- A total of 18 tests were made by September 1983. Three of the last six tests were failures even under laboratory conditions. The Pershing 2 has never had a successful full system test and yet deployment is planned as scheduled in December 1983 (30).

- The Tomahawk cruise missiles that are on the Navy's newly renovated battleship New Jersey may not work properly. The missiles and their computers guidance systems have been "decertified" because they are unreliable. Nonetheless, the New Jersey is already at sea carrying some of them. Last January 1983, then-deputy Defense Secretary Frank Carlucci said the New Jersey's missiles would not be fully tested but would be available for emergency use. "The Navy Tomahawk has had a long history of problems" (31). These Tomahawks are not nuclear although they can be made so.

- "The aging Titan 2 missile system is becoming increasingly troublesome to repair and should be dismantled as soon as possible, the Air Force says" (32). Delay in dismantling increases the chance of accidental propellant spills from liquid-fueled missiles. Also aging hardware is less reliable. Complete deactivation of these missiles is scheduled by September 1987.

- U.S. nuclear weapons scientists report that an explosive substance used in nuclear warheads is highly volatile and subject to accidental detonation. The compound LX-09 remains in hundreds of American Poseidon warheads. The warheads are gradually being replaced, but this will take three to five years (33).

It may only take one missile flying over or crashing into another nation's territory to ignite a nuclear exchange. How reliable are other nations' missiles? How far does each nation want to go in using inadequately tested weapons? Remember another nation may not know whether an errant missile has a nuclear or conventional warhead. Should not all nations announce weapons tests ahead to avoid this type of accident?

D. Conventional Weapons Increasing Destructiveness

How Conventional Weapons Can Trigger A Nuclear War

The growing destructiveness of conventional weapons is increasing the possibility that they can trigger a nuclear war in the following ways (34).

- A participant in a local war might resort to nuclear weapons to avert an overwhelming defeat.

- Conventional arms can be used to deliver nuclear weapons. Conventional aircraft and missiles can be converted to deliver nuclear weapons as can 8-inch and 155-millimeter howitzers.

- Conventional arms sales increase the risk that sellers will become involved in local wars, e.g.
  - to help survival of regime
  - to save military secrets
  - to demonstrate superiority of weapons
  - to insure payments for arms

- It is difficult if not impossible to tell the difference between conventional and nuclear weapons. For example, radar may not be able to ascertain whether incoming missiles are armed with conventional or nuclear munition so that in the heat of battle a nation may respond with nuclear weapons.

- There has been an enormous psychological threshold that may have prevented new use of nuclear weapons. Integrating nuclear weapons into conventional weapons systems tends to reduce this special handling increasing chance for nuclear weapon use.

Increasing Efficiency of Conventional Weapons

Recent technological innovations are making conventional arms far more lethal and destructive than ever. The distinction between nuclear and conventional weapons is decreasing, as illustrated by the following.

- Cluster bombs of the type used in Lebanon scatter "bomblets" which can kill or maim all exposed people over an area up to seventy-five square city blocks (34).

- Smart weapons or precision guided munitions have a high "kill probability." Guided by a minicomputer they can seek out the infrared or electromagnetic signature of the target. It was such a weapon that Argentina used to sink the British destroyer

Sheffield in the Falkland war (35). What if it locks onto the wrong target signature?

- New explosives have been developed that are similar to small nuclear explosions. A "fuel-air explosive" (FAE) can dispense a cloud of highly volatile fuel (e.g. propane) which when ignited produces a powerful blast capable of leveling city blocks. A FAE of this type was used in Vietnam (36, p. 442).

- Conventional weapons can be surgically precise. They are actually replacing nuclear weapons used in anti-submarine and anti-armor warfare (37).

Size of the Problem

It can readily be seen from the above that conventional arms are radically altering the nature of future warfare. "Their introduction will produce a battlefield with no rear, one on which anything that moves or gives off heat or sound can be targeted by powerful weapons with a kill probability near 100 percent" (36, p. 443). Such wars can produce vast military and civilian casualties.

Conventional weapons are "conventional" only in the sense that they are non-nuclear. They may be as common as the handgun or as unconventional as napalm and white phosphorus. "While such arms may be less efficient than nuclear weapons in killing large concentrations of people rapidly, they are no less effective over the long run. According to some estimates, more than 25 million people have died since World War II in conflicts fought exclusively with conventional weapons" (38).

While much of the concern in the arms race is about nuclear weapons, the conventional arms race is proceeding with relatively little notice. According to the Stockholm International Peace Research Institute, 90 percent of what the world spends for arms a year, is devoted to conventional forces. Third World countries are spending more and more of their scarce capital on conventional weapons, and in many cases now are capable of fighting wars of near-nuclear intensity (38).

"According to the U.S. Arms Control and Disarmament Agency, some $145 billion was spent worldwide on imported arms between 1969 and 1978 (in constant non-inflated 1977 dollars), of which 75 percent - $107 billion - was expended by Third World countries. Most experts agree, moreover, that this figure is likely to double or triple during the current decade. As a result, the arms inventories of countries like Iran, Israel, Syria, Saudi Arabia and Libya will more and more resemble those of the front-line states in NATO and the Warsaw Pact" (38).

"What makes the Middle East so dangerous in this regard is that both superpowers have established close arms-supply relationships with potential belligerents. During the 1973 Arab-Israeli war, both the United States and the Soviet Union transported arms directly to their allies in the war zone, narrowly averting a head-on collision. Next time we may not be so lucky" (39).

"More and more Third World countries are developing their own arms industries. At the beginning of the 1970s, only a handful of Third World countries-principally Israel, Brazil, Argentina, and South Africa--possessed a significant arms production capacity. As the decade progressed, however, many of the more affluent Third World countries initiated programs to establish modern arms industries and even, in some cases, to become major arms exporters. As a result, 15 or so of these countries are now capable of producing at least some modern arms, and the number is likely to double in the 1980s. What this will do, of course, is to increase the levels at which Third World countries can sustain warfare, and to decrease the chances for effective multilateral restraints on arms transfers" (40).

"Most of the advanced arms ordered in the late 1970s have not yet been delivered. Because of the long "lead time" involved in the production of modern aircraft and warships-as much as five to six years-many of the most sophisticated weapons ordered by Third World countries in the late 1970s and early 1980s will not be delivered until the mid-1980s. Thus the 60 supersonic F-15 fighters ordered by Saudi Arabia in 1978 will not be ready until 1983 and 1984, and the five AWACS patrol planes ordered in 1981 are not scheduled for delivery until 1985 and 1986. Indeed, so vast is the

backlog that by the end of 1979 the United States had more weapons in the pipeline-$55 billion worth-than it had actually delivered during the previous ten years. If we assume that the French and Soviet backlog is of a similar magnitude, then it is likely that the Third World countries are still awaiting delivery of at least $100 billion worth of arms" (40).

The growing destructiveness of conventional weapons is increasing the possibility that a local war can escalate into a global war. The U.S., U.S.S.R., Britain and France are the main suppliers of arms to the Third World countries. There is a great need to be assessing the overall consequences of our actions.

E. Biological Or Chemical Weapons Can Accelerate Danger

Biochemical weapons development can increase the possibility of a nuclear war in the following ways.

- Since the technology for biological and chemical warfare is growing and deployment is difficult to verify, fear of these weapons is growing. This can be especially true, if a scientific breakthrough occurs which might provide an opponent an overwhelming advantage for a first strike.

- Their use is unverifiable at the time of dispersal. With no warning someone could bring a vial into any country. How would that country react?

- Fear that an opponent is developing or obtaining a hideous new weapon can prompt other nations to strive for similar weapons, which in turn drives other nations to want more deadly weapons, etc.

- A participant in a local war might in desperation resort to biochemical weapons in order to avoid losses. The nation that is attacked with biological or chemical weapons may decide to counter-attack with nuclear weapons.

Biochemical weapons could destroy the very life sustaining capacity of the soil and all agriculture without a trace of who caused it. A nation's people may have to invade another country

just to survive. The following examples illustrate how deadly biochemical weapons can be.

Chemical Warfare

For use in regular battlefield munitions no other poisons match the nerve gases. Depending on the violatility of the particular agent, nerve gases can be released from munitions as a cloud of vapor or as a spray of liquid droplets dispersed by explosives. They can enter the body by inhalation or by absorption through the skin. They cause a wide array of symptoms: intense sweating, filling of the bronchial passages with mucus, bronchial constriction, dimming of vision, uncontrollable vomiting and defecation, convulsions and finally paralysis and respiratory failure. Depending on dosage, death can be in a few minutes to a few hours. There is evidence that sublethal exposure can produce long-lasting neurological and psychiatric disorders (41).

Chemical weapons can cause massive civilian deaths. While the military may or may not have protection, the cost of protecting millions of civilians with masks and shelters is prohibitive so we are not protected (42). In World War I, extensive use of poison gas resulted in over a million casualties and over 10,000 deaths (43). In Japan, since World War II, there have been 102 accidents due to improperly disposed of chemical weapons (44).

Biological Weapons

Biological agents have not been used as major military weapons, therefore, discussions of their potential threat rest heavily on field and laboratory experiments. Understanding the threat also rests on studies of naturally occurring outbreaks or epidemics of infectious disease which still occur.

Molecular biologist Jonathan King describes the danger thus. "Numerous natural viruses, bacteria, rickettsiae (a special group of microbes), and fungi could be enlisted as biological weapons. To kill or incapacitate humans, diseases such as Q-fever, cholera, yellow fever, epidemic typhus, eastern equine encephalitis, anthrax, and pneumonic plague could be intentionally introduced. An equal

list of disease agents can be used to attack agricultural plants and animals. For example, to destroy livestock, viruses are probably most effective. These agents could not only kill animals directly but perhaps would require compulsory slaughter to prevent the spread of infection to other animals and even humans" (45).

"Because they are able to reproduce, biological agents are generally far more potent, weight-for-weight, than chemical agents. Chemicals are usually toxic at doses in the milligram range, while biological agents can act at doses down to trillionths of a gram. Biological agents can also spread over broader areas, multiplying as they pass from organism to organism. And if an agent establishes itself in some niche in the ecosystem, it may persist for a very long time" (45).

Biological agents can be delivered militarily in two ways: by air as aerosols and by dispersion in water. In one field study, 200 kilograms of a harmless powder was released from a ship off shore into the air. The resulting aerosol spray covered 5,000 square kilometers (3,000 square miles) with enough materials to do serious harm. By comparison the same amount of nerve gas would have been lethal over only 50 to 150 square kilometers (45).

Radiological Weapons

Besides biochemical weapons, radiological materials constitute a danger. As radioactive wastes continue to accumulate throughout the world, some nation locked in a desperate struggle may seek to use their materials to their advantage, thereby escalating the war. Radioactive waste, from almost any nuclear reactor, can also be used to contaminate an area. These wastes contain about 200 radioactive isotopes of various kinds, many of which are mortally dangerous even in minute quantities (46). Once obtained, radioactive materials could be dispersed in a variety of ways, such as: attaching a leaking container to a taxi cab, inserting radioactive materials in a closed air system, or attaching materials to conventional explosive. Besides desperate countries, terrorists could use these materials (47).

If a nuclear reactor is destroyed by a nuclear attack it can

cover a large area with radioactivity. Fetter and Tsipis calculated that one month after the explosion of a one megaton bomb on a one gigawatt nuclear reactor the area that would remain uninhabitable would be four times larger than an area where a bomb alone had been detonated. One year later, it would be twenty times larger. Of the approximately 75 nuclear reactors in the United States, at least twenty-two are within 25 miles of a city of 100,000 people or more, and the situation in Europe is more dangerous (48).

Biochemical Arms Race

While Russia and America have the most chemical weapons, China and France have also produced them. Other nations may have chemical weapons but aren't talking (49, p. 276). There have been many articles published in the open literature on how to make nerve gas (50, p. 232-239).

U.S.S.R. Weapons

According to the U.S. Department of Defense the Soviet Union has a formidable capability to wage chemical warfare. "The USSR possesses a variety of lethal and incapacitating chemical agents and the means to deliver them, including missiles, rockets, artillery, and aircraft. They have a large and well-trained chemical organization. They have a large and expanding chemical proving ground, and they train with actual, though diluted, chemical agents. They have invested heavily in protective and decontamination systems and have distributed these widely to their forces (51).

The U.S. Department of State says the Soviets have been using these weapons. "Taken together, this evidence has led the U.S. Government to conclude that Lao and Vietnamese forces, operating under Soviet supervision, have, since 1975, employed lethal chemical and toxin weapons in Laos; that Vietnamese forces have, since 1978, used lethal chemical and toxin agents in Kampuchea; and that Soviet forces have used a variety of lethal chemical warfare agents, including nerve gases, in Afghanistan since the Soviet invasion of that country in 1979" (52, p. 6).

It is difficult to determine if chemical weapons have been used, as proof is difficult to obtain, especially if only one

trillion of a gram is enough. Independent scientists have found the State Department's initial charges inadequate (53). As far as the arms race is concerned, however, it is only necessary for other nations to believe the other side is using them to stimulate a drive for similar weapons.

U.S. Weapons

The U.S. stocks of lethal chemical munitions total approximately 150,000 tons, referring to the weight of the munitions themselves. Nerve gas munitions comprise about two-thirds of this total. According to the emminent authorities Meselson and Robinson, "Approximately 30 different types of nerve-gas munition have been approved for the operational inventories of U.S. armed forces over the past three decades, half of them having been produced in quantity. Some are now obsolete and have been or are being discarded. Remaining in the stockpile are about three million artillery projectiles (105-millimeter GB shells, 155-millimeter GB and VX shells and eight-inch GB and VX shells), several thousand 500- and 750-pound GB aerial bombs, hundreds of thousands of two-gallon VX land mines and about 1,500 160-gallon VX aircraft spray tanks" (41, p. 40).

Despite these vast stockpiles and 30,000 nuclear weapons, the U.S. was considering producing more chemical weapons. For the first time since 1969, the U.S. was planning to produce more nerve-gas weapons. In November 1983, by a one vote margin, the U.S. Senate approved $124 million for a new family of nerve gas bombs and artillery shells. In December 1983, Congress deleted the funds (54). It seems incredible we have three million chemical artillery projectiles and some still wanted more for deterrence.

Need Control Agreements

There has been an enormous explosion of knowledge in genetic engineering. "Mankind has entered a period of rapid and accelerating understanding of the fundamental biochemical and cellular processes of life. As knowledge expands, so too will the range of its possible applications for good and ill" (41, p. 47). Terrorists could set up dangerous laboratories. The need for arms agreements is becoming urgent.

Fortunately, there is an encouraging example of how agreements can be helpful. In 1972 a Convention* was signed by the U.S., U.S.S.R. and Britain on biological warfare. President Nixon called it "the first international agreement since World War II to provide for the actual elimination of an entire class of weapons from the arsenals of nations" (43, p. 122). "The Convention called for the destruction or conversion to peaceful purposes of all biological warfare agents, toxins, equipment and means of delivery within nine months of the convention's entry into force" (55, p. 23). The U.S. Senate voted its almost unanimous approval and President Ford signed it in 1975. The Convention did not include chemical weapons.

From 1977 to 1980, the United States and the Soviet Union participated in 13 rounds of negotiations in an attempt to reach agreements on a verifiable chemical weapons ban. Unfortunately no agreement has been reached (51). Hopefully, as awareness grows of how the lack of agreements is contributing to the possibility of an accidental war, agreements will be achieved. If the U.S. and U.S.S.R. are able to come to terms, the next step would be to present a multilateral agreement to all nations.

* Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (43).

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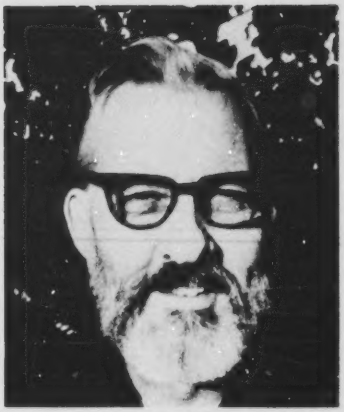

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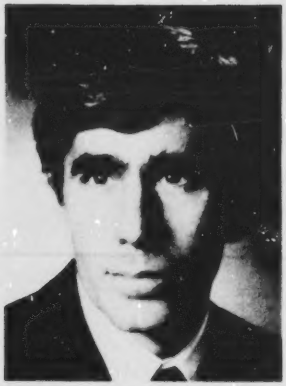

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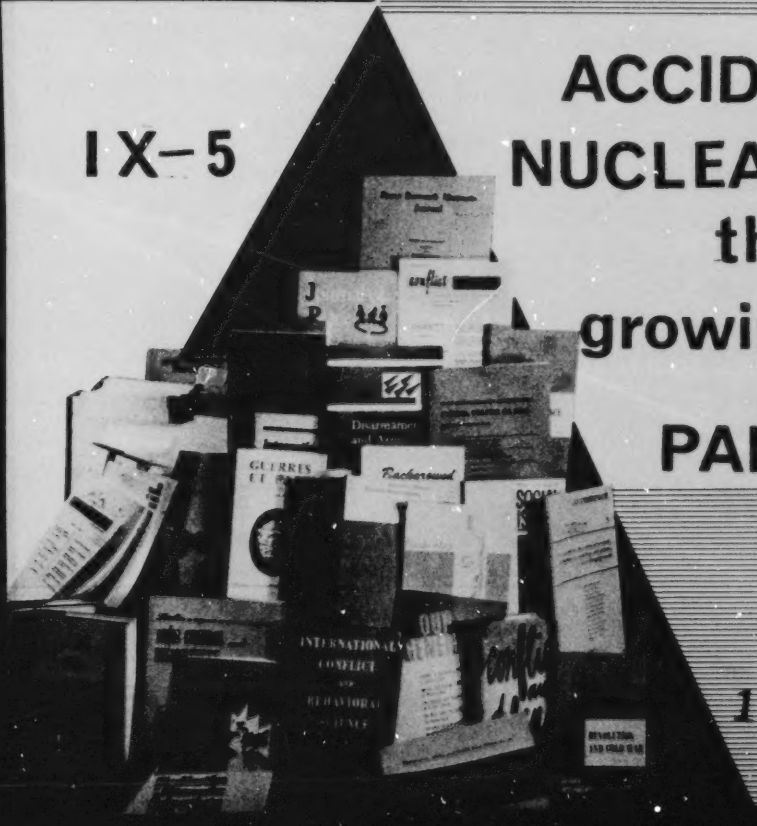
ACCIDENTAL NUCLEAR WAR: the growing peril

PART II



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Chapter VI. LOST IN SPACE:
SATELLITES AND ACCIDENTAL NUCLEAR WAR

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From the opening of the space age in 1957, when the Soviet Union orbited a 184-pound bleeping sphere called Sputnik, the primary impetus behind superpower space programs has been military. While the most immediate military application of infant Fifties space technologies--the intercontinental ballistic missile--was arguably the most highly destabilizing, the secondary application--satellites--was comparatively stabilizing.

For instance, when it began orbiting early warning satellites in 1960, the United States boosted its tactical warning of Soviet missile attack from the roughly ten minutes provided by Distant Early Warning (DEW) and Ballistic Missile Early Warning System (BMEWS) radars to the approximately 30 minutes that still pertains today--at least for ICBM launches (1). Warning of SLBM attack remains a perilous six to 12 minutes. While an extra 20 minutes warning time seems small cause for celebration, in an era of push-button global warfare every second of decision time counts.

The use of satellites for aerial photo reconnaissance has been equally important in at least marginally stabilizing the arms race. So closed, so secretive and so paranoid is the Soviet Union, the United States needs every means possible of monitoring its military activities lest it fatally over-react to imagined Soviet programs. The best example of this was when a U.S. SAMOS (Space and Missile Observation System) satellite, first successfully launched in 1961, deflated the fictitious "missile gap" that had led to such overwhelming levels of overkill in planned U.S. ICBM programs (2). Satellite reconnaissance continues to play a major role both in military surveillance and as the centerpiece of the National Technical Means of verifying compliance with arms control agreements.

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Increasingly, however, military space programs are moving beyond the well-established realms of early warning, surveillance and communications and into the uncharted waters of "force multiplication" of earth-based weapons and even actual space combat. The implications of an accelerating military race in space are grim. Not only does it add yet another tier of competition to an already overburdened arms race but it opens up another vast arena for misunderstanding, miscalculation and accident. As the "space architecture" of both superpowers takes shape, the tens of thousands of miles of useable space surrounding the Earth promise to become perhaps the most fertile field for the seeds of accidental nuclear war.

Even a necessarily brief look at the ever-expanding range of military tasks carried out by the United States' satellites reveals the extent to which any threat to these systems--real or imagined--could conceivably trigger an action/reaction cycle leading to accidental nuclear war.

What the Pentagon refers to as "command, control, communications and intelligence," or C^3I, is a basic prerequisite for the current U.S. "deterrent" posture of maintaining a capability to wage protracted, limited nuclear war. Trident II, MX and Pershing II are certainly just as central to this strategy, but are worthless if they can't reliably be told what to do and when. C^3I, then, forms the central nervous system of the U.S. nuclear arsenal; increasingly, its neurons are comprised of satellites. To this end, more than $10 billion is spent annually by the U.S. on military satellites, a figure that is expected to grow by 10 percent annually (3).

The DoD's first imperative is to maintain what it calls "strategic connectivity." This entails ensuring that its C^3I satellites can survive a "space warfare environment," possibly involving nuclear explosions, electronic warfare (jamming and "spoofing") and anti-satellite (ASAT) weapons.

In the late 1970s, the Air Force was looking to upgrade its AFSATCOM (Air Force Satellite Communications) network, which has been piggybacking largely on the Navy's FLTSATCOM system with no dedicated satellites of its own. It envisioned an elaborate system

of satellites orbiting a safe 110,000 miles out (most satellites are found at 22,300 miles) with emergency spares in lunar orbit (4). When this system, called STRATSAT, was zeroed by a cost-conscious Congress in 1981, the Air Force fell back on MILSTAT, Which Maj. General Gerald Hendricks, vice commander of the Air Force Space Division, claims "is designed to be a warfighting system, the first of its kind."(5) By 1990 the eight-satellite MILSTAR fleet, jam-proofed and equipped with substantial evasive maneuvering capabilities, will be ready to stitch together the tactical and strategic forces the U.S. has scattered around the globe and, if needs be, deliver Emergency Action Messages, the nuclear attack orders (6).

MILSTAR and other third-generation battle management and C^3I spacecraft, such as DSCS III (Defense Satellite Communications System)--a six-satellite system for super-high frequency communications between Washington and overseas bases--will have nuclear hardened electronics to guard against nuclear explosion generated x-rays and electromagnetic pulse (EMP) (7). The Defense Nuclear Agency has conducted extensive, and reportedly successful, underground nuclear tests to gauge the survivability of satellites (8). It is, however, highly debatable how nearly such tests can approximate an actual space warfare environment.

Just as important to a nuclear warfighting doctrine as survivable C^3I is unprecedented targeting precision, a capability that will be afforded by the 18-satellite NAVSTAR Global Positioning System, due to be completed in 1988. By beaming out a continuous stream of navigational cues, NAVSTAR/GPS will provide precise position and velocity determination within tens of feet, a fraction of a mile per hour and a millionth of a second (9). When NAVSTAR/GPS is mated with the Trident II (D-5) submarine-launched ballistic missile (SLBM), beginning in 1989, the U.S. will have at its command the world's first SLBM capable of ICBM counterforce/first strike accuracy.

The implications of this for an enduring peace are worrisome, to say the least. SLBMs have traditionally been considered stabilizing deterrents, insofar as they are too inaccurate for counterforce attacks but are invulnerable to attack themselves.

But the 3,256 Trident II warheads the U.S. will have deployed by 1997 will put the more than 70% of warheads the Soviets have on ICBMs at considerable risk--and with only six to 12 minutes warning time. The tremendous pressure this invulnerable, counterforce armada will exert on Soviet decision makers creates a dangerous impetus for miscalculation in a time of crisis.

NAVSTAR/GPS receivers will also go into all U.S. B-52, FB-111, B-1B strategic bombers, as well as the MX, future generations of advanced cruise missiles and, likely, the proposed "Midgetman" single-warhead, small ICBM (10). The great increase in accuracy afforded by NAVSTAR/GPS poses the contradictory dangers of simultaneously increasing U.S. confidence that unrealistic precise and localized nuclear targeting strategies can be carried out, while impelling the Soviets to fire everything they have in a desperate "use 'em before you lose 'em" assault.

Piggybacked on the NAVSTAR constellation will be a force multiplying sensor known as the Integrated Operational Nuclear Detonation Detection System, or IONDS, which General Bernard Randolph, director of Space Systems C3 Research, has called "critical in terms of the priorities that the Strategic Air Command has." (11) The reason for this prioritization is not hard to grasp, considering IONDS will report instantaneously which Soviet targets have been successfully destroyed by U.S. warheads. By allowing precise, knowledgeable retargeting of undestroyed Soviet silos, IONDS will boost the silo kill potential of the Minuteman III force alone by as much as 40 percent (12). "With IONDS," writes Thomas Karas in *The New High Ground,* "a 'first strike' intended to disarm the other side's ICBMs looks feasible with a far smaller arsenal than before." (13)

The capabilities of IONDS will mesh neatly, from a warfighting perspective, with those of the improved Defense Support Program (DSP) satellites, due to be deployed next year. These upgraded early warning satellites will be able to report exactly how many missiles have been launched from which Soviet silos, in contrast to the less specific warning information provided by the current DSP system. Again, as with NAVSTAR/GPS, IONDS and DSP will backfire on the very advocates of precision nuclear warfighting who have

urged their development. If the U.S. can discern and swiftly destroy those silos which are still loaded (at the same time denying a reload capability) then the Soviets would have little choice but to use everything they have in one massive, uncoordinated barrage.

Of course, nothing ever goes as planned-especially in the midst of what Clausewitz so accurately described as the "fog and friction" of battle. However magical it often seems, modern military technology cannot repeal Murphy's Law. If anything can go wrong with these high tech gizmos, it probably will. The peril before us is not so much that this complex, space-based nuclear war machine will work as designed, but that its growing sophistication has seduced our leaders and planners into believing that the precise, limited and protracted nuclear conflict now envisioned actually has some grounding in military and political reality.

The import of force multiplier programs for the possibility of accidental nuclear war is that there is increasingly little likelihood-if indeed there ever was any--that an unintentional nuclear exchange could be terminated before overwhelming destruction has been wreaked. The steadily mounting lethality of our missiles, thanks to space-based force multiplication, means that nuclear war, however it starts, will more resemble the "wargasm" described by the late Herman Kahn than the controlled march up and down the ladder of escalation posited by Secretary of Defense Caspar Weinberger.

A number of military space programs not likely to mature until sometime in the next decade or even century will also further shave down the nuclear hair-trigger. The Defense Advanced Research Projects Agency's Teal Ruby program, a space-based infrared staring mosaic sensing system, is designed to detect and target jet aircraft and even cruise missiles. Originally scheduled for a feasibility test in 1983, technical complexities have pushed back the first flight test until sometime in 1986 (14). If it proves out, Teal Ruby, like other less capable target-acquisition systems, will increase the speed and lethality of war once it breaks out and the temptation to adopt first strike or preemptive strategies (15).

Both the U.S. and the Soviet Union are working on blue-green laser programs, designed to penetrate the ocean depths from space to communicate with friendly submarines and detect enemy boats (16). If ongoing R&D on blue-green lasers proves successful, the consequences could be shattering for strategic stability. Not only will U.S. submarines become more flexibly integrated into the Single Integrated Operational Plan (SIOP, the U.S. nuclear war-fighting blueprint), but Soviet submarines will become highly vulnerable to attack. This would, in effect, be the last, essential piece of the puzzle for a plausible first strike capability. Even if the U.S. has no intention of launching such an attack, Soviet anxiety will make for very nervous fingers on the Russian trigger.

Unfortunately, just as satellites are becoming more integral to nuclear warfighting plans, they are also increasingly vulnerable to attack from anti-satellite (ASAT) weapons. Over the past two-and-half decades the U.S. has conducted 25 ASAT tests, beginning in 1959 when a Bold Orion rocket fired from a B-47 bomber intercepted a spacecraft over Cape Canaveral (17). Other U.S. ASATs tested over the decades involved large, land-launched rocket boosters armed with nulcear kill mechanisms. The last such operational ASAT system, mounted on a Thor rocket based on Johnston Island in the Pacific, was dismantled in 1975.

In 1968, the Soviet Union began testing a "killer satellite" launched on a large SS-9 missile. Once in orbit it maneuvers into proximity to its target, destroying it with a barrage of shrapnel. Of some 20 tests of the killer satellite, the Soviet Union has achieved about a 50 percent success rate (18). In 1984, the U.S. tested a far more capable, direct-ascent ASAT, a Miniature Homing Vehicle, fired from an F-15 fighter plane.

At present, neither side is able to threaten the most important C^3I and force multiplier satellites in geosynchronous earth orbit (GEO), 22,300 miles up. However, before the MHV/F-15 ASAT was tested, the Pentagon was already studying follow-on air-, sea- and ground-launched systems for attacking Soviet satellites in GEO (19). More ominous is the emerging link between ASAT R&D and the redoubled efforts to achieve an advanced anti-ballistic missile (ABM) capability kicked off by President Reagan's "Star Wars" speech of March 23, 1983. According to White House Science Advisor,

Dr. George Keyworth, an important "near-term milestone" for space-based ABM development is a geosynchronous ASAT. "It may not necessarily be the best way for an ASAT mission," Keyworth said, "but a geosynchronous ASAT capability is important to test the technology to destroy missiles.... With emphasis this can be done in less than five years." (20)

Even were the Earth's surrounding space truly an empty wasteland, these developments would be alarming enough. But, in truth, space more resembles an orbiting junk yard. It is the job of the Space Defense Operations Center (SPADOC), working out of NORAD's headquarters deep under Cheyenne Mountain in Colorado, to meticulously track and catalog the orbits of some 5,000 human-made orbiting objects, only 250 of which are operational. On the basis of 30,000 observations a day, SPADOC can track any object larger than four inches across (21). Smaller, unseen fragments could number in the tens of millions.

Part of SPADOC's job is to advise space users of "launch windows" and safe orbits based on the location of identified debris. More importantly, it tracks space trash so NORAD's early warning sensors don't confuse the burn up of reentering garbage with an enemy missile launch. On October 3, 1979, however, that is exactly what happened. According to a 1980 Congressional report, "an SLBM radar (Mt. Hebo) picked up a low orbit rocket body that was close to decay and generated a false alarm and impact report (22). This system failure was profound enough to cause a NORAD Threat Assessment Conference, the final step before the fateful, as yet never held Missile Attack Conference calls in the President to make a launch decision.

Whipping around the Earth at six miles per second, collision of even a tiny fragment with a live satellite would be devastating. Twice in 1983 inhabited space vehicles were hit by space objects. A window on the Soviet Salyut 7 space station was struck and cratered in July and, earlier, the space shuttle Challenger suffered similar damage (23). In September 1983, an Indian communication satellite was struck only seconds after release from the Space Shuttle cargo bay by an unidentified space object measuring eight inches across. This, apparently, was one piece of garbage SPADOC failed to spot. (24)

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In a 1981 position paper on space debris, the American Institute of Aeronautics and Astronautics warned: "At the present time, the collision hazard is real but not severe. However, continuation of present policies and practices ensures that the probability of collision will eventually reach unacceptable levels, perhaps within a decade." (25) The AIAA study notes that the number of trackable objects in space is expected to increase by a factor of two to eight within the next 20 years, depending on the number of explosions in space (there have been more than 60 space explosions so far.) At that rate of increase, AIAA predicts, the "collision frequency between a 50-meters diameter spacecraft and the 1-centimeter population in the year 1995" could approach 0.25. (26)

What would happen if a crucial satellite suddenly went blind during a tense international crisis? Would the Air Force Space Command simply assume it was struck by a fragment of space junk? Or would it suspect this was the first ASAT shot of a Pearl Harbor in space? It should be noted that suspicion on this count already runs high, with U.S. officials charging that there have been "at least two major malfunctions" of U.S. satellites due to illumination from Soviet ground-based lasers and that another major malfunction "may be due to foul play." (27)

Yet to be fully addressed are the incalculable contributions to accidental nuclear war scenarios arising from the so-called "Star Wars" space-based ABM system. Although the directed energy technologies necessary for such a defense network are largely untried, all indications are that the Pentagon plans to press ahead with--if not a crash program--at least a very strong push. (28)

As was pointed out by innumerable commentators following President Reagan's March 23 speech, Star Wars, far from making weapons of mass destruction obsolete, is rather a precondition for an unanswerable first strike. As such, it would more likely than not spur a renewed offensive arms race coupled with a new defensive arms competition. Therefore, unless the pace of deployment of this missile screen is perfectly symmetrical between the superpowers--an unlikely prospect--the tensions introduced into the strategic standoff could make for rocky going indeed. Conceivably, the Soviets might even feel sufficiently cornered as to launch a

preemptive attack before the screen is erected, though it is improbable that they would be so rash.

Another source of danger is posed by the proposed basing modes for a future space-based ABM. Since a pre-deployed laser satellite constellation would be vulnerable to attack, a "pop up" system is envisioned, by which the defensive satellites would be rapidly deployed on tactical warning of Soviet attack (29). Since duration of the Star Wars conflict would be measured in seconds, initiation and prosecution of the planetary battle would be too rapid for human participation and so would have to be conducted by advanced computers endowed with artificial intelligence. (30) Space-based defense would, by necessity, be a launch-on-warning system. If U.S. sensors or computers generated an error and the U.S. launched its defensive satellites accidentally, it could trigger the very Soviet offensive it was designed to deflect.

Accidental nuclear war will not happen casually or simply. The inhibitions against nuclear launch are high and are likely to remain so for the foreseeable future. But, as the nuclear systems of both superpowers becomes increasingly more complex, as the amount of tactical and strategic information available becomes an undigestible tidal wave of data, as dependence on vulnerable force multipliers becomes more absolute, the margin for error shrinks accordingly.

As the nuclear front line is extended out into space, the opportunities for catastrophic nuclear error and miscalculation are astronomically increased.

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Chapter VII. ASSESSING PROBABILITY OF AN ACCIDENTAL NUCLEAR WAR

A. Need For Overall Estimate

Humanity could be greatly underestimating the danger of an accidental nuclear war because of our tendency to look piecemeal at the different ways an accidental war could start. In this respect, there is a great need to assess the overall danger very carefully and publish the findings widely.

In our desire to assess the probability of an accidental war, we wrote to the U.S. Congress' Office of Technology Assessment asking their ideas on the subject. In October 1982, we received a gracious letter from them which said that the actual probability of such an accident appears quite low (1). The letter concluded as follows: "While in the nature of things the probability of accidental nuclear war will be greater than zero so long as nuclear weapons exist, I know of no way of estimating the actual probability. Nor do I know of any way of determining whether the probability is rising or falling over time; some events (such as nuclear proliferation) may increase the risk, while others (such as the discovery and correction of procedural or hardware problems) may reduce the risk. These judgements are all very subjective and I do not believe that we can be of any further assistance on your project" (1).

Nigel Calder, in the process of writing his book *Nuclear Nightmares*, interviewed key people in many nations. He observed "there are remarkably few people in the world who take a broad overview of nuclear war and can offer a knowledgeable opinion, say, on whether the new cruise missiles are 'stablizing' or 'destablizing' for the strategic balance" (2, p. 13).

Despite the great need for accurately knowing the likelihood of an accidental nuclear war under different conditions, almost nothing is being done to assess the factors which contribute most to danger. It is suggested that such assessments be carried out by Accidental War Assessment Centers proposed in the next Chapter (VIII). It is recognized that such studies will be large and complex tasks. The purpose of this Chapter is to describe briefly possible ways such estimating can be done.

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B. Analytical Procedures For Mathematical Estimates

We know of only two studies that have attempted to estimate the probability of an accidental nuclear war. Both are recent and very preliminary as any such beginning efforts must be.

Drs. Frei and Sonntag mathematically estimated the overall probability of a nuclear war. The estimate is made in the book, *Risk of Unintentional Nuclear War* (3, p. 222). The authors acknowledge that their brief estimate is very crude and subjective. They presented it with the hope that it might offer some indication of the relative significance of the various risks and the logic of their interrelationships. They note that the combination of risks is more dangerous than the mere addition of single risks. Some of the accidental war risks they considered in their model are false alarm, nuclear accidents and human failures.

Dr. Bernard Bereanu developed a mathematical model for estimating the probability of a nuclear war occurring by accident (4). In his model, he takes into consideration two factors: (1) computer software error in warning systems and (2) strategic nuclear weapons components breakdown. His work suggests under certain plausible conditions the probability of an accidental war approaches unity (certainty).

His findings need to be taken very seriously and assessed further, especially when one considers that it is based on only two of the many factors discussed in this book. Professor Bereanu is anxious to make his work more widely known. He is a Research Professor of Mathematical Statistics at the Institute for Pure and Applied Mathematics in Bucharest, Romania. His paper is being circulated among researchers by Professor Michael Wallace of the University of British Columbia, Vancouver, B.C., Canada.

While there are few studies that attempt to directly estimate the probability of an accidental war, there are related studies that can be used for guidance in any beginning effort. These related studies include methods used in making large scale estimates of complex dangers.

The Rasmussen Reactor Safety Study was one of the most thorough and expensive safety analyses in history. It was a study that supposedly proved that nuclear energy plants are safe, until the accident at Three-Mile island proved otherwise. While the study has its problems, the event-tree/fault-tree methodology it pioneered for estimating accident possibilities deserves careful consideration (5).

Another example, of large scale risk studies, is the RAND Institute liquefied natural gas (LNG) assessment. In order to meet the energy shortage, the possibility of shipping LNG into the U.S. was considered. Several risk studies were made of the possible danger to port cities receiving the tankers. If a spill should occur there could be a tremendous explosion. Ultimately, due to a variety of reasons, no LNG has been shipped into the country. These assessment projects do provide useful examples of how large scale risks can be assessed (6, 7).

In industry, Pareto's method is used to prioritize and combine risk estimates into an overall estimate. Essentially, judged probabilities are ranked from highest to lowest and then added together to obtain an overall figure (8). This method has the advantage of indicating which factors are most important in order to know where to focus prevention efforts.

One way to obtain the judged probabilities is to have a panel of knowledgeable people make an estimate for each risk. Then the average of the estimates can be taken as the "best" estimate for each scenario.

While the panel method is based on subjective judgement, it does represent a group judgement of informed people. Much can be done to help the panel in making the "best estimates" possible. For example, in this book, each of the 15 scenarios has the following elements whenever available to help in the judging process.

- Examples of how the scenario could trigger a war.
- Indications of size and scope of the problem.
- Indications of frequency and trends of the danger.

The panel procedure provides a process by which many persons can cooperate in developing an estimate. The procedure is readily

understandable to a wide audience. The more international the composition of the panel the more other nations should have confidence in the estimates. Since some of the factors have political-strategic ramifications, the panel should be representative of various political persuasions.

The above studies show that there are a variety of procedures for assessing large scale risks. Statistics can provide a valid approach for all repetitive type phenomena. For example, such events as terrorist acts, wear and tear on equipment and human fallibility are all recurring and predictable.

There is an urgent need for public and private agencies to carefully assess the overall danger of an accidental war. In the process of making the estimate, there are many things that can be done to improve them.

- Scenarios described in this book need to be refined as to mutual exclusiveness, operational definition, etc.

- New and better data need to be gathered on each scenario as to frequency, scope, and trends.

- Mathematical relationships between scenarios need to be refined, e.g. converging trends, magnifying factors. Interdisciplinary teams are needed to carry out estimates.

Developing sophisticated analytical models for estimating accidental war potential under various conditions eventually requires quantifiable measures. For example, Dr. Alan Newcombe and his associates are in the process of developing a "Tensiometer" for predicting war using mathematical measures and formulas that could prove very helpful (9). Another source of help can be the quantitatively expressed physical, biological and social descriptors used for evaluating technological hazards (10).

There are other studies that may provide useful data and procedures for refining the accidental war estimates. As an example, Ivo and Rosalind Feierabend have developed computerized "fever charts" which use many measures in order to predict the

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stability of countries (11). The War Ledger provides a ten year study of war factors that could be helpful (12).

It is much easier to criticize mathematical models for assessing nuclear war dangers than to show how the problem should be analyzed. It is well to remember, therefore, that all political and military leaders' overall assessment of nuclear war dangers are only based on subjective judgements. A systematization of our judging process could prove very helpful in knowing where to focus our prevention efforts.

Proper assessment of accidental war dangers will require top level scientists and risk analysts and will be costly projects. Even fully funded, however, major assessment projects would cost only a fraction of what is spent for weapons research, development and manufacture.

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Chapter VIII. PREVENTION

A. Need Increased Public Awareness Of Peril

Public Opinion Surveys Show Little Awareness

Accidental nuclear war is probably the greatest danger to the security of the world and yet the public is little aware of it. For example, repeated surveys in the U.S. rank economic problems as much more important than fear of war. The following table contrasts these attitudes. It is encouraging to note that war concerns have increased from 1982-1983.

The answers below were made in response to the following question:

What do you think is the most important problem facing this country (U.S.) today (1)?

Main Problem	December 1983	October 1983	October 1982
Threat of war and international problems	37%	23%	6%
Economic issues-unemployment, recession, inflation	55%	65%	91%

Columns do not total 100% because other problems are not included.

In a 37 year summary of U.S. attitudes toward nuclear war, there was not one question on a war occurring by accident or miscalculation (2, p. 33-40). In a similar 30 year summary of American and European polls, no such questions were found (3, p. 126-134). All issues of *Public Opinion* and *Public Opinion Quarterly* for 1978 through 1981 were reviewed and no articles on accidental war were located. These journals also report polls that list the most important problems people are anxious about. In none of the surveys is a war by accident or miscalculation ever mentioned.

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While fear of war, accidental or intentional, may not be the main worry of most people in the U.S. there is nevertheless a concern. In June 1983 in the U.S., 71 percent of the public said they favored an agreement between the United States and the Soviet Union for an immediate and verifiable freeze on the testing, production and deployment of nuclear weapons (4). Another indication of concern is the U.S. American Roman Catholic Bishops' overwhelming condemnation of nuclear warfare and the arms race. Backing for the Bishops' action came from 32 major Protestant and Eastern Orthodox denominations (5).

Opinion surveys are needed to learn how well informed the public is on various ways an accidental war could start. The public's attitude could change very rapidly as more references are made to accidental war. For example, how much impact is the hit movie "War Games" having on awareness, regardless of the accuracy of the depicted scenario? Especially, when at the same time the movie is playing, students in Milwaukee were actually tapping into many computer systems - one of which is the national nuclear-weapons laboratory computer in Los Alamos, New Mexico (6). Also the Korean Airliner disaster will probably increase awareness of accidental war possibilities.

Need Growing Awareness

It is not adequate that only a few nations be anxious about an accidental war. Since a missile exchange in one part of the world might ignite a worldwide exchange, it is crucial that all nations become greatly concerned about prevention.

As fear of an accidental war grows, the desire for self-preservation should spark attention in all nations. This is possible if the growing concern is based on reliable information that is clearly communicated. An indication of how concern can be communicated internationally occurred when the U.S.S.R. showed on television, to 100 million Russians, the International Physicians for Social Responsibility's film, "One Million Hiroshimas." The film, discussing the horrors of nuclear war, was the same as shown in the U.S. Also, the dangers of a "Nuclear Winter" are being discussed in Russia.

It will take a tremendous amount of concern throughout the world before nations will agree to the tough, verifiable controls required for preventing an accidental war. It is necessary to communicate the possible destruction of humanity so forcefully that prevention becomes the world's number one priority.

The following sections describe specific measures that can be taken to prevent an accidental war. Surprisingly, they are all inexpensive measures. None of the measures undermine nations' security and none of them are particularly technically difficult. They are more a matter of getting opposing nations to agree. Agreement should occur when nations become more fearful of an accidental war than of each other.

B. Need Improved Hot Line

Twenty years ago the United States and the Soviet Union, mindful of how close they had come to nuclear war during the Cuban missile crisis, inaugurated a "hot line" connecting the White House and the Kremlin. It is a teleprinter connection that enables the two nations' political leaders to communicate quickly. "The hot line has never been as secure as one might hope. The super powers lost contact at least six times between 1964 and 1966"(7).

Because of the increasing danger of a nuclear exchange being triggered by accident or misunderstanding, the U.S. Congress in 1982 ordered the Pentagon to study improvements. In April 1983, in response to this request, the Department of Defense made specific proposals for bolstering hot line communication listed below (8). Defense Secretary Weinberger said, "These are very simple things: they would benefit everybody" (9). Discussions on these measures between the Soviet Union and the U.S. opened in August 1983 and are continuing (10).

Until the improvement proposals are implemented, however, it means the U.S. and U.S.S.R.:

- Will not be able to use a high-speed satellite network.
- Will not have high-speed facsimile transmission capability of sending maps.

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. Will not have a secure voice and video capability.

. Will not have a direct bilateral Military Communications Link.

. Will not have high-speed links from their respective capitols to their embassies in crisis nations.

. Will not have a bilateral, face-to-face crisis control center.

The above shows how terribly unprepared the two superpowers will be if a crisis erupts. We remain dependent upon a slow printed message, while time for decision making has decreased from many hours to only a few minutes. As indicated in Chapter II, this is a very sad condition when it is realized that both nations and humanity could be accidentally destroyed at any time. Hopefully, by emphasizing mutual security needs, negotiations for implementation can be quickly completed. Some people have suggested that there be a television link-up between the U.S. and the U.S.S.R.

C. Need Better Crisis Control Communications Between Nations

U.S. - U.S.S.R. Joint Crisis Control Center

U.S. Senators Sam Nunn, John Warner and Henry Jackson proposed that a permanent Soviet-American Joint Consultation Center be established (11, 12, 13). The new institution would facilitate immediate information exchange and consultation between the two countries when events occur that could trigger a nuclear war not intended or desired by either side. The jointly staffed and operated Soviet-American consultation center would be in operation every hour of every day in a mutually agreeable place.

Senator Nunn asks questions that forcefully show an urgent need for the crisis center. "How would the Russians react if a low-flying aircraft with U.S. markings delivered a nuclear device on one of their cities? Do they have the capability to determine the true origin of the aircraft? Would stunned and angry Russians react calmly and cautiously or would they draw immediate conclusions and launch a nuclear attack against America? How would we react if a nuclear device exploded in a ship of unknown origin in San Francisco harbor and obliterated the city? Will we sit idly by

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while the possibilities grow in the years ahead that a fanatical leader may attempt to rid the world of the superpowers by pulling a Third World trigger?

"Are these unreal science fiction fantasies or is there a growing possibility of a third-party or terrorist use of nuclear weapons? At my request last spring, Gen. Richard Ellis, then commander of the Strategic Air Command, undertook the evaluation of the possibility of a third party triggering a superpower nuclear exchange under a variety of scenarios. Unfortunately, this evaluation showed that there are real and developing dangers in this area" (11).

In November 1981, Senator Nunn first proposed a crisis control center for preventing such events as described above from triggering an accidental war (11). In September 1982, the U.S. Congress asked the Department of Defense to study the possibility of a multinational crisis control center. In April 1983, the Defense Department concluded a crisis control center would not be desirable at this time. First, they wanted more experience with operating a joint military communication link - a link which has not been established either.

Where is the sense of urgency in the world? It seems to us there is a critical need for a crisis control center servicing many nations. As the number of nations with nuclear weapons grows, the possibility of some fanatical leader or terrorist group triggering a nuclear war increases. Will the world be ready to contain it when it occurs?

Could a crisis control center prevent such a tragedy as the shooting down of the Korean Airlines plane in September 1983? The Soviets tracked the plane for 2½ hours. During such a lengthy period, the plane's errant flight path could have been discussed and resolved if communications were better. How will the next crisis be handled?

Confidence-Building Measures

President Reagan, in November 1982, proposed to the Soviet leadership several Confidence Building Measures for preventing an

accidental war (8). The following measures were proposed.

- Advance notification of U.S. and Soviet missile launches,
- Expanded exchange of data on intermediate-range nuclear forces as well as strategic forces,
- Advance notice of major strategic exercises.

In *Risks of Unintentional Nuclear War,* additional confidence building measures are discussed (14, p. 196). Among those suggested were the following:

- Drafting a code of conduct for observer activities at military manoeuvres so that exercises will not be taken as hostile acts.
- Exchange of annual training calendars.

It is encouraging to know that discussions between the Soviet Union and the U.S. on stability-building measures opened in August 1983 and are continuing (10). Until implemented however, they leave unresolved many possibilities for an accidental war.

D. Need Accidental War Assessment Centers

Why Needed

As nuclear weapons become more widespread, automated and complex, and as time available for decision making decreases, the probability of an accidental war increases.

The world is spending many billions of dollars a year on weapons' research and almost nothing on how to prevent an accidental nuclear war, our greatest danger. As shown in the previous Chapter (VII), there are few studies that assess which factors are most dangerous for prevention planning and fewer still that estimate the overall probability of an accidental war.

There is no reason why we should continue to proceed in ignorance, as accidental war questions are researchable. While the

issues are large and complex they can be broken down into questions of answerable size.

Nations need to be assessing how rapid technological advances in weapons are increasing the possibility of an accidental war. We need to be examining whether each major weapons change, by increasing the chance of an accidental war, really adds more to our security than it detracts. In the latter part of this section are many questions, that need to be answered. These questions illustrate the type of information needed.

In order to systematically assess accidental war dangers as accurately and rapidly as possible, the studies need to be continuous and focused on key questions. One vehicle for carrying out such studies could be accidental war assessment centers.

Congressional Accidental War Assessment Center*

In order to show how a nation could quickly establish an accidental war assessment center the following specific guidelines are proposed for the United States. It is to be hoped they will prove useful to other nations.

- The Congressional Assessment Center should continually take an overall view. Since the peril of an accidental war is far larger than the perspective of any one agency, the Center should be a Congressional operation.

- The Center should be created on a trial basis so that it has to prove its usefulness. Those analytical units within the Center that can provide meaningful answers quickly can be expanded and the other analytical units reorganized or disbanded. The assessment tasks will be difficult and the challenge great with short deadlines.

* Some of the ideas in this section were presented by the authors to the U.S. Congress' Subcommittee on Appropriations, when asked to testify on the defense budget. Reported as "Congressional Assessment Center For Accidental War", *Department Of Defense Appropriations For 1984 - Hearings*, U.S. Gov't. Printing Office, Washington, D.C. 1983, pp. 590-594.

- The Assessment Center should be a coordinating study group. It should not try to answer the many complex problems alone. The analysts need to work closely and sensitively with other agencies and non-governmental groups.

- The Center must have access to information necessary to answer Congressional concerns. Part of its job, by statute, should be to examine relevant system failures.

- The Center must assess accidental dangers independent of executive agencies. This is especially true, when it is remembered how differently the Department of Defense and Congress can view the danger (Chapter III).

- The assessment should be operational in nature and must not stray from the focus on accidental war prevention.

- The Center should share its reports widely and seek constructive criticisms quickly. The reports need to be clear, and concise, and they should state methods, assumptions and limitations. Hopefully other nations will use the reports and assess the peril independently.

- The Center should try to obtain help from other nations in assessing common dangers, e.g. what are other nations' false alarm experiences.

The cost of the Assessment Center would be minuscule compared with defense costs. Does it make sense for Congress to be appropriating hundreds of billions of dollars annually for defense and not have its own continuous independent overall assessment of the gravest threat to our existence, accidental war?

As long as the peril is great, we need annual Congressional hearings to help assess accidental war dangers and increase world awareness. It is to be hoped that other countries, and some private foundations, will assess accidental war dangers for themselves. Much needs to be done and time may be short.

Accidental War Questions

There are many accidental war questions that are crucial to our survival. The following questions provide examples. It is urgent that political and military leaders be asking these questions. As the public becomes aware of these questions, it is to be hoped they will also demand answers.

1. Will stealth weapons increase accidental war possibilities?
   The U.S. plans to spend more than $100 billion for cruise missiles, B-1B bombers and Advanced Technology Bombers (15). All are being designed to attack with no warning. Other countries are building similar weapons. As far as is known, nothing has been spent by any country on assessing how much such weapons increase the possibility of an accidental war. As the number of nations that can be attacked with no warning grows, the possibility of a country launching missiles to a false alarm or misjudged threat grows.

2. How can we allow the Soviets only 8 minutes or less for eliminating false alarms before launching their missiles at us, when we have no knowledge of their false alarm experience?

   Isn't such mass blindness the same as world suicide? If not, why not?

3. How long will it be before some nation launches to a false alert?
   As an indication of how asleep the world is to this peril, nations with strategic warning systems are not even sharing false alarm information basic to their mutual security. The U.S. is the only nation that has published information on its problems, thanks to Congress and the General Accounting Office. How much concern is being given to preventing a war based on the false alerts of France, China, or other nations that have recently acquired nuclear weapons or are experimenting with launch vehicles (Libya and Argentina)?

4. To which countries are cruise missiles being sold?
   France sold cruise missiles to Argentina. How widespread are cruise missiles becoming? With their ability to fly under radar and carry out sneak attacks, these weapons will make nations increasingly "trigger happy." The miscalculation of just one nation may be all it takes.

5. How likely is a missile exchange anyplace to trigger a global war?
   Remember, an electromagnetic pulse travels at the speed of light and can disrupt communications over a continent. Even if the U.S. and U.S.S.R. have some systems hardened against EMP chaos, what about the remainder of their systems and those of other nations? With much of the world blacked out, what will be the psychological reaction?

6. What is the extent of international technological terrorism?
   Is the Nuclear Nonproliferation Treaty capable of accurately monitoring the spread of weapons technology?

E. Need Arms Reduction And War Containment Agreements

The purpose of this book is to increase the motivation of all nations for tough, verifiable arms reduction agreements and war containment measures. There are many arms reduction proposals, but what is lacking is a powerful worldwide feeling of urgency for implementation. No one nation can do it alone. There are few war containment proposals.

In the previous section, a series of questions showed how each nation's safety is becoming increasingly dependent on worldwide security. For example, while the U.S. and U.S.S.R. are slowly striving to reach arms reduction agreements, some other country might intentionally use or accidentally explode nuclear weapons. At this time the world is not adequately prepared to contain such a war. With nuclear proliferation, the danger is growing.

Reducing the probability of war is far more important than

tinkering with numbers of weapons. As the reaction-time fuse becomes shorter and weapons systems become more complex, automated, and widespread, the danger of an accidental war grows. As important as arms reduction is, crisis control and war containment are more urgent.

One of the most important war prevention moves the U.S. could make is to not shorten the time-decision fuse by placing Pershing 2 and cruise missiles in Europe. Accordingly, the Soviets and other nations must simultaneously move back their missiles for their own safety.

On the positive side, it is important to remember that there are many arms-control agreements already in force. These agreements provide guidance for developing more treaties. According to Dr. Frei, two main groups of agreements exist that are particularly relevant for the prevention of unintentional nuclear war. His book has an excellent description of these agreements (14, p. 180).

Agreement open to admission by all States

Name of Agreement	Date Signed
Antarctic Treaty	1959
Limited Test Ban Treaty (LTBT)	1963
Outer Space Treaty	1967
Treaty of Tlatelolco	1967
Nuclear Non-Proliferation Treaty (NPT)	1968
Seabed Treaty	1971
Confidence-Building Measures of the CSCE Final Act	1975

Bilateral agreements mostly between the Soviet Union and the United States

Name of Agreement	Date Signed
Hot Line Agreement	1963
Agreement to Reduce the Risk of Nuclear War	1971
Agreement on the Prevention of Incidents on the High Seas	1972

Name of Agreement	Date Signed
Basic Principles	1972
SALT I (Interim Agreement)	1972
ABM Treaty	1972
Prevention Of Nuclear War Agreement	1973
SALT II (Never ratified but adhered to by the U.S. and Soviets)	1979

A worldwide sense of urgency is needed in creating new preventive agreements. While discussions to achieve an intermediate range missile (IMF) agreement and a strategic arms reduction (START) agreement are efforts in the right direction, much more is needed. Additional treaties of the following type are needed to help prevent an accidental nuclear war.

1. An Agreement to follow certain procedures, including time delay and communication with the other side, in the event a nuclear detonation takes place anywhere on earth.

2. An Agreement to refrain from moving to a launch-on-warning position.

3. An Agreement to pull back, or preferably remove, battlefield nuclear weapons from central Europe.

4. An Agreement for a major cultural exchange between citizens and leaders of the U.S. and the Soviet Union, as an educational program and as a restraint on the intentional use of nuclear weapons, i.e., as hostages.

5. An Agreement on limitations of anti-submarine warfare development, testing and emplacement.

6. An Agreement to ban testing and emplacement of anti-satellite devices.

7. Resumption of negotiations on a Comprehensive Nuclear Test Ban Treaty and involvement of more nations than just the U.S., Britain and Soviet Union.

Disarmament By Challenge

A concept gaining in popularity is disarmament by challenge rather than by negotiation. Either superpower could make a unilateral restriction for a given period of time (such as not deploying Euromissiles or removing some SS-20s). Then if the other responds within the specified time with a like initiative, the initial restriction becomes permanent. Either side could then move on o further steps, possibly including cooperative verification. This system has the advantage of putting world opinion in favor of the first unilateral step and world pressure for a response. It also eliminates the falderal of negotiations. With the vast overkill both sides have, it should be given a try.

Power Realignment Within NATO

Recently British and French political leaders and Franz Josef Strauss, leader of the majority coalition in West Germany (Christian Social Union), have called for a Dual Key Arrangement. Under such an arrangement, the U.S. would be unable to fire any Euromissiles without direct consent from the host country.

The more nations that can fire their nuclear weapons independent of all other nations, the greater is the possibility of some one nation firing its weapons. In this sense, a power realignment within NATO that restricts unilateral action might help reduce the possibility of accidental war. A power realignment may also bring our European allies into a more coherent political, economic and military entity. Such a union may create less tension by diminishing European differences between the U.S. and the U.S.S.R.

F. Need Additional Security Measures

Much more can be done to help reduce the risk of an accidental nuclear war than thus far described. Dr. Frei in his book (14, p. 223) lists 32 measures that can be taken to reduce risk. A few of these measures are listed below to illustrate these needs.

1. The more complex and sophisticated weapons technology becomes, the less efficient are traditional means of verification within national means. As the possibility of miscalculation or misjudgement increases, effective

verification becomes increasingly important. It is, therefore, imperative to study and develop new procedures of verification, e.g. inspection teams from neutral nations.

2. In arms reduction negotiations and public discussions, there is a strong emphasis on equality in numbers of weapons. Actually, small qualitative differences (hit probabilities, quality of C^3 systems, etc.) are much more important. Arms control should increasingly be directed towards the qualitative arms race, even if verification is difficult.

3. Crisis communication Hot Lines should be developed between many more nations than just the U.S. and U.S.S.R.

4. One of the dangers of armed intervention in local crisis spots is that it could escalate. The major Powers should develop a "code of conduct" for restricting their involvement in third world conflicts.

5. Concepts need to be studied which could contribute to securing strategic stability at a lower level of armaments.

6. Another possibility that could increase security, although it is not mentioned in Frei's book, is to make U.S. foreign aid depend on ratification and allowance of inspection under the Nuclear Proliferation Treaty.

G. Need Long-Term Goals For World Peace

In the long-run, a lasting peace needs to be built on more than war containment and arms control measures. Due to rapid technological advancements in weapons, war in one area of the earth might engulf the world. Also the world is becoming very interdependent and, due to rapid communication and transportation, very small. Eventually "some kind of world authority" is needed to beat the nuclear sword into plowshares and bring a permanent peace to the earth (16).

We need to learn how to build a peaceful world in a positive manner. The proposed United States Academy of Peace could provide a step in this direction. Part of its function would be research

in resolving conflict without violence (17). The Rev. Theodore Hesburgh, President of Notre Dame University, said "We need an Academy of Peace, then, not to do away with conflict, but to learn and teach...how to creatively 'manage' conflict..." (17).

In 1983, a majority of U.S. Senators cosponsored a bill to create a National Peace Academy. More than 100 Representatives sponsored similar legislation in the House (17). It is hoped that this legislation can be enacted soon.

In an earlier paper, the authors suggested that the Peace Academy could help the Accidental War Assessment Center assess key dangers with which they are familiar. Richard Sullivan of the National Peace Academy Campaign responded to this suggestion by saying, "Clearly, there can be no short-term goal more important than finding ways to reduce the risk of an accidental war breaking out. I can't imagine that the Peace Academy would not of necessity be involved in such an effort" (18).

Research can be helpful in building a permanent peace. Studies have shown that people can live together in peace. Dr. Rudy Rummel, in a 20 year study published in five volumes, showed that political and economic freedom reduces war as well as the threat of war. He summarizes many studies, including his own, to demonstrate that violence will not occur between states that emphasize individual freedom, civil liberties and open competitive election of leaders (19).

H. Need For Action

Accidental nuclear war is a growing peril. If we continue to do little to prevent it, it can destroy us all. If we can convince all nations that they need to be much more fearful of an accidental war than of each other then all nations could be moved to arms reduction agreements. In this sense, fear can be converted into hope by providing a basis for building a peaceful world.

Since most people are only vaguely aware of the possibility of an accidental war, you can do something by helping those around you become more aware of how such a war can start. Fear and hope

can be contagious. You are not alone. For example, this book or its SUMMARY is being sent to leaders in every country in the world, as well as many individuals and libraries.

We never met a person who is opposed to preventing an accidental war. How content are you to make no effort to prevent the accidental destruction of your family, country and world?

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POSTSCRIPT: WHO IS RESPONSIBLE?

A haunting question remains: If there were an accidental nuclear war, unleashing the tremendous destructive power of even a small portion of our nuclear arsenals, who would be responsible for this tragedy?

Would it be the political leaders who, forced by the constraints of time and pressure, made the decision to launch the missiles?

Or the military leaders who argued for ever more complex and frightful nuclear weapons systems?

Or the congressmen who appropriated the funds for them year after year?

Or the industrial leaders who profited from the arms race and lobbied to keep it well-fueled?

Or the scientists and engineers who lent their brain power to the creation of increasingly powerful and accurate weapons?

Or the soldiers who obeyed their orders to fire the missiles?

Or the "enemy" who competed in the arms race?

All of these will share in responsibility, but the major responsibility will lie elsewhere. It will lie with each of us who has remained silent as we've moved closer and closer to the precipice. It will lie with the parents and grandparents who did not chose by their actions to secure the future for their children and grandchildren. The true responsibility will lie with you and me, wherever we live, whatever our name.

* * * * *

After a nuclear war it will not much matter, of course, where blame is placed, But if each of us were to accept responsibility now and act to reverse the nuclear arms race, then -- with luck

and courage and energy -- we might never again (as at Hiroshima and Nagasaki) need to experience the horror of nuclear war. Accepting this personal responsibility is the greatest and most necessary challenge of our time. It is the cornerstone of a future that carries civilization, and even life, forward.

We invite you to join in seeking the prevention measures outlined in this book, and to become a personal force for peace in the nuclear age.

APPENDIX A

THE U.S. STRATEGIC WARNING SYSTEM AND ITS PROBLEMS

I. Description Of System And False Alarms[1]

The Missile Attack Warning System consists of three major parts. (1) sensors to detect missile launch, (2) computer centers and communication links to analyze and distribute the data from the warning sensors, and (3) command posts where the implications for the warning information are assessed and appropriate actions directed. Major components of each segment are as follows:

MISSILE WARNING SENSORS

- Infrared warning satellites
- Ballistic Missile Early Warning System (BMEWS)
- PAVE PAWS, a phased array radar for detecting submarine launched ballistic missile. (SLBMs)
- Perimeter Acquisition Radar Attack Characterization System (PARCS)
- Two radars in the southern United States for detecting SLBM launches
- Cobra DANE radar in Alaska

COMPUTER COMPLEXES AND COMMUNICATION LINKS

- Ground stations in the Continental United States and overseas
- Other computer processing stations colocated with the sensors

COMMAND POSTS

- North American Aerospace Defense Command (NORAD) (Cheyenne, Colo.)
- Strategic Air Command (SAC) (Omaha, Nebraska)

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1. Excerpted from Reference 1 - Emphasis added by authors.

- National Military Command Center (NMCC) (Pentagon)
- Alternate National Military Command Center (ANMCC) (Fort Ritchie, Maryland)

The missile warning system employs a two-step process for identifying a missile launch and assessing the threat to the North American continent. First the infrared warning satellites detect the infrared signature of the burning missile motor.

Ground-based radars provide a second source of data - the radar signature of a burning missile motor. The BMEWS radars would be the first to detect soviet intercontinental ballistic missiles (ICBMs); the Pave Paws would be the first to detect SLBMs launched off the east or west coasts. Two older radars located in Florida perform the same function for missiles coming from the Gulf of Mexico.

The dual phenomenology detection system has been a fundamental and critical design feature of our missile warning system for many years and provides an important cross-check for evaluating ambiguous data.

According to the Hart-Goldwater report, if the Soviets were to launch SLBMs and ICBMs separately or simultaneously, the following sequence of events would most likely take place. The first indication of missile launch would come from the satellites, followed next by Pave Paws detection of SLBMs and several minutes later BMEWS detection of ICBMs.

- The satellites should detect launch of both the SLBMs and ICBSs shortly after launch.
- The Pave Paws radar should pick up the SLBMs within minutes after launch.
- The BMENWS should pick up the ICBMs several minutes later.
- The PARCS should pick up the ICBMs in their terminal phase of flight.

These estimates pertain to detection and processing of data in the United States. Estimates for Europe could be significantly longer.

The time between launch and impact of SLBMs could be short and less than that of the ICBMs. The time between launch and impact of ICBMs would be about 30 minutes. Since SLBMs could destroy a large part of our ground-based sensors and command posts, it must be assumed that the time from detection to the impact during which we will have full use of our present system could be short. This does not mean that the entire system would disappear at the end of this period, but that we would become dependent on those assets that could survive the initial attack, in general those which become airborne in time to escape the attack. So there is a high premium on the full and effective utilization of the short period between detection of attack and destruction of a major part of the command and control infrastructure.

The satellites and the Pave Paws radar, the two sensors that are designed to detect attack of SLBMs, feed their data directly to all four major command posts (NORAD, SAC, NMCC, and ANMCC) so that all four are looking at the data received directly from the sensors and are evaluating it simultaneously. NORAD also transmits to the other three command posts so that duty officers at the three command posts (SAC, NMCC, and ANMCC) have two separate computations and displays of SLBMs attack data, one coming directly from the sensors and the other from NORAD. Data from NORAD are also transmitted to the other 3 command posts.

NORAD, a functional partnership between the United States and Canada, has the responsibility for (1) providing warning of attack on North America by bombers and/or ballistic missiles, (2) surveillance of space to keep track of all man-made objects orbiting the earth, (3) maintaining, in peacetime, a surveillance of North America capable of detecting and identifying unknown aircraft, and (4) providing a limited defense against bombers in the event of an attack on this continent.

When there is any indication of a real threat or even ambiguous data, the four command posts begin a formal conferencing procedure to evaluate and assess the data. Three types of formal conference are used:

- Missile Display Conference.
- Threat Assessment Conference.
- Missile Attack Conference.

MISSILE DISPLAY CONFERENCES

The satellites trigger the warning process by observing the infrared signatures of the missiles and comparing them with previously observed infrared signatures from Soviet missiles. Unfortunately, there are other physical phenomena both in the atmosphere and on the Earth's surface which can give similar infrared indications. The detection system must be sensitive enough so as to not miss any missile launches but still not overburden the system with irrelevant information. Achieving this balance is a continuing problem. As a result of the need to maintain a sensitive system, there are many indications of detections that have to be evaluated but prove not to be associated with a threatening missile launch. In addition there are routine missile display conferences called when changes are made in the positioning or configuration of the sensors that might cause the system to yield unusual information. In 1979 there were 1,544 routine missile display conferences that were necessary to deal with events other than threatening or ambiguous missile launches. There were 78 missile display conferences called to evaluate detections that were possibly threatening to the North American continent. In 1980 through June 30 there were 2,159 routine missile display conferences and 69 called to evaluate possible threats to North America.

All 3,703 of the routine missile display conferences held in 1979 and through June 30, 1980 resulted from actual pickup by warning sensors of some physical phenomenon or reconfiguration of warning sensors. In addition to these incidents there is the possibility that a computer or a piece of communications equipment will transmit a false piece of information. This happens with some frequency although prior to the June 3 and June 6 (serious false alarms) incidents records were not kept of actual incidents. NORAD spokesmen indicated it may happen two or three times a year. These incidents result from random failures within the computer and communications hardware and software and not as the result of external stimuli.

So there are several sources of false indications of warning that are possible, including the actual detection of an infrared signature which must be evaluated because it bears close enough resemblance to an ICBM or SLBM signature so that it cannot be ignored and the random malfunction of a piece of computer and communications equipment. The missile warning system handles on a daily basis the problem of sorting out false indications of attack from potential real indications of attack. The missile display conference, the first step in evaluating sensor data, is terminated when the Commander-in-Chief (CINC) of NORAD makes the judgment that all the available data indicate no danger. If not, airborne command post prepares for takeoff as survivability measure. SAC commander has authority at all times.

THREAT ASSESSMENT CONFERENCE

If the NORAD Commander determines the possibility of a threat, the next step is to convene a threat assessment conference. This brings more senior people than the duty officers at the various command posts into the evaluation, such as the Chairman of the Joint Chiefs of Staff. A threat assessment conference is convened to determine the nature of the threat to North America and to direct preliminary steps to enhance force survivability. In 1979 and 1980 there were four threat assessment conferences. They were called on the following occasions and for the following reasons:

October 3, 1979, -- An SLBM radar (Mt. Hebo) picked up a low orbit rocket body that was close to decay and generated a false launch and impact report.

November 9, 1979, -- False indications of a mass raid caused by inadvertent introduction of simulated data into the NORAD Computer System.

March 15, 1980. -- Four SS-N-6 SLBMs were launched from the Kuril Islands as part of Soviet troop training. One of the launches generated an unusual threat fan. (Testing happens often in troop training).

June 3, 1980. -- False indications caused by a bad chip in a communications processor computer.

MISSILE ATTACK CONFERENCE

If the threat persists, the final action taken is to convene a missile attack conference which brings in all senior personnel including the President. No such conference has ever been convened.

AN EXAMPLE: CAUSE OF THE JUNE 3 AND 6, 1980 INCIDENTS

The failure was caused by a faulty intergrated circuit in a communications multiplexer. The communications multiplexer is not part of the data analysis computer, but is part of the communications system which takes the results of the analysis and puts it into message form for transmission to the other command posts. The multiplexer forms the message which NORAD transmits continuously to all command posts plus to the Canadian Headquarters in Ottawa in order to have a continuous check on the condition of the circuits.

Interviews with Air Force personnel indicate that within minutes of receiving a first indication of threatening missiles all of the command posts concluded the data were erroneous. They reached these conclusions based on three observations: (1) there was no indication from the sensors of any detection of missiles; (2) the indication on the display that was being received from NORAD did not follow any logical pattern or sequence of events that would be expected from a missile launch; and (3) the different command posts were receiving significantly different indications. The data appeared to be random.

There seemed to be an air of confusion following the determination that the data were erroneous. This raises the question that when compared with data or scenarios that are different from what would be the most likely scenario, can the procedures and trained personnel deal with an unusual situation in such a way that they do not negate the effectiveness of the entire system while they are searching for the cause or source of stray or erroneous data. In other words, while controllers at the various command posts were quite effective in recognizing and dealing with

erroneous data, could they have dealt with a real attack if it were proceeded by stray and erroneous data introduced into the system or launch-on-warning?

This question raises the issue of the effectiveness and usefulness of checklists and training for command post personnel. Clearly, in the event of a real attack, a checklist would be very useful since the pressure and tension would be very high and it would be mandatory that well thought-out procedures developed in advance be available for the use of the controllers and other senior officers. On the other hand, is it possible to develop checklists to cover every possible scenario and is the training given to the controllers adequate to give them a balance between reliance on checklist and application of sound judgment?

As a result of the June 1980 false alarms, the following changes were made.

- First, NORAD has added computer programs that have the effect of tracing a message through the entire message preparation phase to insure that the transmission accurately reflects that which is input through the message system.

- Second, they have added a display in the NORAD command post which will show what is being transmitted to the other command posts. Prior to this, NORAD had no way of knowing what was being transmitted to other command posts.

- Third, the message being transmitted from NORAD to the other command posts has been changed in format. Formerly the message was of the same format that would be used in case of an actual attack, but the space where the numbers of missiles in the attack would be shown was filled with zeros. Now, that message is in a different format which just indicates the status of the communications system rather than any indication of numbers of missiles. Should the communications system at NORAD transmit a message giving numbers of attacking missiles, an alert in the NORAD command post would be triggered indicating a transmission of a real message.

Yet, for all practical purposes, even today the responsibility for the management of the missile warning assessment is divided among three major commands within the Air Force with a fourth, Systems Command (AFSC), being responsible for the development of new equipment for missile warning functions. A System Integration Office was established in 1981.

Such a complicated/decision making system as outlined above raises many serious issues of the availability of time for decision making. This is the network outline for the U.S. alone! What about similar systems/procedures for NATO, its individual member states, U.S.S.R., etc.---?

In order for NORAD to upgrade or replace an element within its command and control system, an inordinate amount of time is required under the current process. The current operational system was conceived in 1968 and was brought on line in 1979.

Further improvements in the NORAD 427 computer system include:

SOFTWARE

(1) Parity and Cyclic Redundancy Check (CRC). -- Provided powerful extension of end-to-end communications validity checking. National telecommunications expertise was used in development.

(2) Status message and format. -- An investigation is underway with the Communication Central Processing and Display System (CCPDS) community (JCS, SAC, National Military Command Center) to restructure missile warning messages.

(3) NCS1/NCS2.(NORAD Computer System) -- Currently coding a scheme to cause a software switchover in the event of a failure from the Primary NCS to the Secondary NCS for 100 percent backup of missile warning processing.

HARDWARE

(1) Data Monitors. -- Have been placed on critical Missil

Warning Display System (MWDS) lines to alarm operations personnel whenever an active missile warning message is sent.

(2) CSS Upgrade. -- Replace the Honeywell 6050 message processors with II6060 computers.

(3) Digital Television Element (DTVE) By-Pass. -- Develop a by-pass to the unreliable DTVE system.

(4) Display Information Processor (DIP) By-Pass. -- Develop an interim by-pass for the 20-year old DIP, currently used as an alternate communications routing device for the UNIVAC 1100/42.

(5) Missile Warning Display System (MWDS)Circuit Upgrade. -- Convert all the MWDS circuits to a fully coordinated (Advanced Data Communications Control Procedures (ADCCP) Protocol) configuration.

(6) Missile Warning By-Pass (MWBP) Upgrade. -- Develop a permanent replacement for the DIP (4) above, to route critical missile warning data to the NCS and MEBI in the event of CSS failure.

(7) Off-Site Test Facility. -- Develop a complete computer facility electrically and physically separated from the NORAD Cheyenne Mountain Complex (NCMC) to develop and test software and hardware changes to the operational 427M system.

The 427M system is composed of three major segments: (1) the Communications System Segment (CSS) which provides essential communications support for NORAD headquarters, (2) the NORAD Computer System (NCS) which provides critical missile warning information, and (3) the Space Computational Center (SCC) which detects and tracks all man-made satellites in space.

Despite the critical nature of the NORAD facility and the increased emphasis on upgrading its capabilities, the 427M upgrade

program is not yet completed. It has been subject to schedule delays, excessive cost growth, and reduced mission performance capabilities. In fact, the 427M program is more than six years behind schedule and has cost overruns of almost $150 million over the projected cost of the computer upgrade. More importantly, the upgraded system will only have an information processing capability essentially equivalent to that of the 1966 system that it replaces.

The General Accounting Office (GAO) reported that there were two basic reasons for the failure of the 427M upgrade in its May, 1981 report, "NORAD's Missile Warning System: What went wrong?" MASAD-81-30. First, NORAD was directed in 1970 by the Joint Chiefs of Staff to use the World-Wide Military Command and Control System (WWMCCS) computer equipment and software, which does not have the capabilities necessary to handle NORAD's information processing requirements. The Commander of NORAD at that time strenuously objected to the Joint Chiefs of Staff, but was overruled.

Second, program management was divided between the Air Force Systems Command and NORAD. GAO reported that fragmented management made it exceedingly difficult to establish and maintain effective administrative control over the program and contractor operations on a daily basis. NORAD's attempts to resolve the problems inherent in the WWMCCS equipment and software and the divided management resulted in the development of an information system that will not improve NORAD's operational capability over that which it has had since 1966.

II. Weaknesses Of NORAD and Worldwide Military Command And Control System[2]

Though many improvements have been instituted at NORAD, some of which we mentioned earlier, the U.S. House Committee on Government Operations and the General Accounting Office have concluded that: Federal ADP acquisition process was in no way responsible for the false alerts at the NORAD facility. Further, it was found that the NORAD facility had been mismanaged over the last decade by the Air Force, the Joint Chiefs of Staff, and the Department of Defense,

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2. Excerpted from References 2 and 3 - Emphasis added by authors.

resulting in obsolete computer systems which do not satisfy the requirements of NORAD's sensitive mission. These obsolete systems, coupled with poor management practices and human error, were directly responsible for the false alerts.

A major factor which contributed to the failure of the modernization program was the 1970 decision by the Joint Chiefs of Staff to force NORAD to use the computer equipment of the World Wide Military Command and Control System (WWMCCS) which was inadequate for NORAD's requirements. This decision was made despite strenuous objections from the NORAD Commander. Like the NORAD modernization program, the WWMCCS project has been plagued by Air Force and Joint Chiefs of Staff mismanagement. The failure has resulted in the expenditure of more than $1 billion in a command and control system that has been judged by the GAO as incapable of meeting a crisis condition.

The Committee believes that the problems at NORAD have reached a critical stage and that priority attention is needed at the highes levels of the Defense Department. Without this emphasis, it is unlikely that this country will have an up-to-date and effective attack warning system.

WHAT IS THE WORLD WIDE MILITARY COMMAND AND CONTROL SYSTEM?

The World Wide Military Command and Control System (WWMCCS) (pronounced WIMEX) is an arrangement of personnel, equipment (including automated data processing (ADP) equipment and software), communications, facilities, and procedures employed in planning, directing, coordinating, and controlling the operational activities of U.S. military forces.

WWMCCS includes the existing command and control systems of the Unified and Specified Commands, the command and control and related management information systems used by the Headquarters of the Military Departments, the command and control systems of the Headquarters of the Service Component Commands, and the command and control support systems of Department of Defense Agencies.

WWMCCS is intended to provide the National Command Authorities (NCA)(the President and the Secretary of Defense) a capability to:

-- receive early warning and intelligence information,
-- apply the resources of the military departments,
-- assign military missions, and
-- provide direction to the Unified and Specified Commands

while supporting the Joint Chiefs of Staff in carrying out their responsibilities.

Success of WWMCCS requires that effective coordination and liaison also be maintained with activities outside the Department of Defense (DOD). Some of these activities include the White House Situation Room, the State Department Operations Center, the Central Intelligence Agency Indications Office, the U.S. Intelligence Board National Indications Center, the U.N. Military Mission, the Office of Emergency Preparedness National Warning Center, the U.S. Coast Guard Operations Center, the Federal Aviation Administration Executive Communications Control Center, and the North Atlantic Treaty Organization.

The National Military Command System, the priority component of WWMCCS, must be capable of exchanging information either directly or indirectly between or among these differing activities. The quick and efficient exchange of information is essential if the National Command Authorities are to make appropriate and timely responses to potential or real threats to our national security. Both the communication of warning and intelligence information from all sources and the communication of decisions and commands to our military forces require that the National Military Command Systems be the most responsive, reliable, and survivable system that can be provided. To meet such requirements, equipment must be compatible, communication links must provide a direct connection or realtime relay whenever necessary, computerized data formats must be common, and all details of system configuration and operation must be as efficient as possible.

The ability of the National Command Authorities to make appropriate and timely responses to potential or real threats also requires that all command and control systems within the Department of Defense be configured and operated for the effective support of the National Military Command System as well as their specifically

assigned missions. For these reasons, the National Military Command System is an essential element of our national security.

An ADP program capable of fulfilling the requirements of the National Command Authorities is integral to the National Military Command System's ability to be responsive. At the present the WWMCCS ADP program is unable to fulfill such a mandate.

WHAT IS WRONG WITH THE WWMCCS ADP PROGRAM?

In the early 1960s, WWMCCS ADP capabilities consisted of a loosely knit federation of approximately 158 different computer systems, using 30 different general purpose software systems, in operation at 81 separate locations. These systems:

-- were not responsive to national level requirements;
-- were not true systems because they were developed separately without sufficient consideration being given to the information requirements of other commands with which they had to exchange information;
-- lacked growth potential;
-- used incompatible hardware, software, and data base structures;
-- could not transfer data and information efficiently;
-- made it extremely difficult to exploit ADP technology because of the vast differences in equipment and software systems.

In short, the WWMCCS has only limited capabilities during times of crisis. This is confirmed by DOD studies.

During the summer and early fall of 1979, DOD conducted a survey of users to obtain their views on the operational performance of the WWMCCS Information System (WIS). The survey information was gathered through interviews with 272 WIS users. Four levels of users were interviewed--Commander-in-Chiefs; functional area deputies such as intelligence and operations; functional area staff officers and noncommissioned officers; and the ADP managers at 27 WWMCCS sites.

The survey showed that, despite its imperfections, users perceive WIS as providing useful support for day-to-day operations particularly for long-term advanced planning for joint military operations. However, for time constrained crisis or conflict, they did not view WIS support as adequate or responsive to their needs. Users gave the following reasons for the system's limited ability to provide responsive support during time constrained situations.

First, the system lacks a state-of-the-art online query/response information retrieval capability. Without this capability users are unable to process and retrieve information when needed.

Second, the WIS including the intercomputer network is not reliable. During times of crisis, the system fails because data and information traffic is at its peak and the circuitry of the main computer is not designed to function in an outline highly interactive environment such as command and control.

Third, source information is not sufficiently timely, accurate or complete for managing time constrained situations.

Fourth, experienced and well-trained personnel are not always available at several WWMCCS sites. This condition impairs the ability to provide timely, accurate and responsive information particularly during times of crisis.

And fifth, command facilities and their supporting information systems including WIS are not considered to be survivable against acts of civil strife, sabotage or war. Thus, users do not believe WIS will always be available when needed.

GAO's evaluation showed that the existing WWMCCS management structure is so complex and fragmented that no one organization or individual has a complete overview of the program or the centralized responsibility for its funding, budgeting, and management. As a result, the WWMCCS program:

Is unresponsive to stated requirements;
Is unreliable;
Lacks economical and effective growth potential;

Is incapable of transferring data and information efficiently;
Makes the exploitation of ADP technology extremely difficult and costly; and
Impairs each command's operational backup capability.

Since WWMCCS is an essential element of United States national security, the mismanagement of this project by the Air Force and the Joint Chiefs of Staff over 15 years has seriously jeopardized our defense capabilities.

In an October 1981 report, the GAO evaluated the Air Force's new plan to upgrade WWMCCS. The upgrade originally was expected to be completed in 1989 at a cost of untold billions of dollars. GAO's evaluation of the Department's WWMCCS upgrade shows that these efforts have been slow, do not address the fundamental issues and will not lead to a timely responsive solution to known WWMCCS problems.

After 14 years, many hundreds of studies, and the expenditure of more than $1 billion, DOD has failed to develop a responsive, reliable, survivable design or provide a firm and detailed planning document describing how to achieve such a design. The performance of the current WWMCCS is so poor that rapid improvements are necessary to minimize continuing critical shortfalls in capability, particularly during times of crisis. But the WWMCCS upgrade planning is proceeding far too slowly to be responsive to these deficiencies. An already unnecessarily long acquisition process scheduled for completion in 1989 may slip repeatedly because of poor management by the Department. Specifically, after 13 years since the start of the WWMCCS program and after more than 2 years since the start of the recent WWMCCS upgrade, the Department:

Has only recently approved a concept of operations for WWMCCS upon which detailed information requirements must be based;
Did not plan to properly define the detailed information requirements; and
Has prematurely selected a computer design, before defining requirements; and
Has only recently established a central manger for WWMCCS.

In spite of numerous studies, which essentially contain the same or similar information and recommendations, DOD persists in an unrelenting pursuit of additional funds to support further studies. This commitment to study at the expense of decisive action prolongs the operation and maintenance of antiquated and dangerously inadequate hardware and software, seriously impairing DOD's ability to provide responsive, reliable support to the National Command Authorities, the Joint Chiefs of Staff, and the United and Specified Commands.

This country will lack a viable command and control system in the 1990's if the Air Force and the Joint Chiefs of Staff continue to refuse to modify their methods of operation and management.

The Air Force, in particular, has experienced many other serious problems in its ADP management over the last decade. Starting in the early 1970's, a series of massive and debilitating failures of large Air Force information systems have occurred. Most recently, the Air Force was severely criticized for a project called Phase IV, the world's largest computer project to date.

But the Navy also has its share: in the *Report of the Navy Automatic Data Processing Acquisition Review Committee,* pages 1 and 2: Navy instructions in many cases are outdated and do not reflect current policy. Users have trouble putting together requirements packages which are adequate; users neither plan sufficiently in advance of their anticipated needs, nor provide adequate advance information of those needs to higher levels of management. The results of these problems are extended time to meet ADP needs.

Some commanders in the Air Force have begun to recognize the seriousness of its ADP management problems. In a letter, dated February 13, 1981, to the Air Force Chief of Staff, Gen. Lew Allen, Jr., the then Commander of the Strategic Air Command (SAC), Gen. R. H. Ellis, stated that:

The Air Force has heeded neither the RAND nor the President's Reorganization Project Report by failing to establish a high-level focus for management in the Air Staff. Little action has been taken to strengthen the Air Force ADP management organization as a

result of ALS, Phase IV or problems in the missile warning system. The obsolescence of our computers and the personnel overhead associated with old technology continues. There remains little career progression for senior ADP personnel in the Air Force, hence their exodus to civilian positions. There is no high-level focus in the Air Force to correct either managerial or technical deficiencies in our systems or to insure that new systems meet requirements.

The Department of Defense's (DOD's) current World Wide Military Command and Control Information System (WIS) modernization program is based on an approach that is similar to that used to select the current WIS hardware. The current hardware has proven to be incapable of handling time-sensitive information processing requirements. Examples of other DOD and service programs that used this approach are: Air Force Advanced Logistics System, Phase IV Navy Advanced Information System; Army Tactical Operating System, Corps of Engineers Management System; and DOD-Tri-service Medical Information System. Each of these programs is considered by DOD and the Congress to be substantially less than successful.

Presently, the modernization effort is planned to be accomplished in three phases over a 12 year period. The system concepts and alternatives are to be defined during the period 1978-1981. Equipment will be acquired from 1982-1989 and the system is not expected to be placed into operation and continue to evolve until 1990. The most critical issue, replacement of the computers, is not scheduled to be completed until 1989. This is a twelve year acquisition cycle for a clearly deficient system. A much shorter replacement cycle is needed to minimize the potential for continuing to experience serious operating problems, particularly during times of crisis.

Up until FY 82, the Cheyenne Mountain Complex of NORAD computers did not even have a second (underground and dedicated) power supply feeder, a new substation, new switchgear, EMP filter and an uninterruptable power supply (UPS) for critical loads. Most other DOD computers do not have uninterruptable power supplies!

These more subtle, split second failures can have an equally devastating effect on an information processing system's reliability. For example, industry studies have shown that 98 percent of the power outages causing a computer to break down are those lasting less than half a second. Also, almost any power outage will cause a disk storage device to be electronically interrupted or disconnected from the computer. This can result in loss or alteration of data being transferred to or from storage.

And what about the other computer links between the U.S. and its decision making centers (such as embassies, ---) in Europe, Middle East, etc.?

One of the most efficient and effective ways to provide a capability to exchange and use time-sensitive information in a rapidly changing environment is to allow the user to obtain the computer capabilities needed but require the use of common protocols, terminology, data elements, data formats, data retrieval techniques, and procedures. Since each WWMCCS site has differing information needs, its needs for computer support also differ. Forcing each site to use the same computer system, as DOD is still tending to do, is no longer necessary with today's state-of-the-art technology. This approach puts DOD into the position of forcing requirements to fit the architecture rather than vice-versa.

References

1. "Recent False Alerts From The Nation's Missile Attack Warning System," by Senators Hart and Goldwater, Senate Committee on Armed Services, U.S. Gov't. Printing Office, Wash., D.C. 1980.

2. "NORAD Computer Systems Are Dangerously Obsolete," House Committee on Government Operations, U.S. Gov't. Printing Office, Wash., D.C. 1982.

3. "Failures Of The North American Aerospace Defense Command's (NORAD) Attack Warning System," Hearings Before A Subcommittee Of The Committee On Government Operations, House of Representatives U.S. Gov't. Printing Office, Wash., D.C. 1981.

APPENDIX B

NATIONS TECHNICALLY CAPABLE OF DETONATING A NUCLEAR DEVICE*

ERDA: Potential Nth Countries, April 1977**

(Indicates technical capability only. There is no speculation inferred on the political motivation to develop a nuclear weapons capability.)

A. Countries which appear technically capable of detonating a nuclear device in the short term (within less than 1 up to 3 years of a decision to do so).

Argentina	Italy
Canada	Japan
Republic of China	South Africa
West Germany	Spain
Israel	Sweden

B. Countries which appear technically capable of detonating a nuclear device in the intermediate term (within 4 to 6 years of a decision to do so).

Belgium	The Netherlands
Brazil	Norway
Czechloslovakia	Pakistan
East Germany	Poland
Republic of Korea	Switzerland

C. Countries which appear technically capable of detonating a nuclear device in the longer term (within 7 to 10 years of a decision to do so).

Austria	Mexico
Denmark	Portugal
Egypt	Romania
Finland	Turkey
Iran	Yugoslavia

* *Nuclear Proliferation Factbook*, Committee on Governmental Affairs, U.S. Senate, and the Committee on Foreign Affairs, U.S. House of Representatives, U.S. Government Printing Office, Wash., D.C., 1980, p. 325.

**ERDA is the U.S. Energy Research and Development Administration.

APPENDIX C*

THE BALANCE OF FORCES

Introduction

Despite the great amount of information on the relative strengt of the U.S. and the Soviet nuclear arsenals, there is no broad consensus as to who is "ahead." The lack of consensus is reflected by a 1982 CBS/*New York Times* poll, which indicated that only 12 percent of Americans thought that U.S. nuclear strength was superior to that of the Soviet Union; 34 percent thought the U.S. was weaker, while 47 percent believed the two superpowers were "about as strong."

Confusion arises because data fail to tell the whole story. The U.S. currently has over 9,300 strategic warheads, while the Soviet Union has over 7,500. But the scales can be tipped to favor one side or the other simply by emphasizing or downplaying different aspects of the respective arsenals. However, careful analysis of the information provided by the International Institute for Strategic Studies (IISS) -- considered by many experts to be the most authoritative, independent source of data on world military forces -- reveals that U.S. and Soviet nuclear arsenals are roughly equal.

This fact sheet compares and interprets IISS data on U.S. and Soviet arsenals of both strategic and theater nuclear weapons. A nation's strategic weapons can strike its adversary's territory from the homeland. Strategic forces include land-based, intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and long-range bombers that may be fitted with nuclear-tipped "cruise" missiles in addition to nuclear bombs. Theater nuclear weapons generally have a shorter range, and are intended for use within a specific arena, such as Europe. They are deployed on a wide range of medium- and short-range missiles, fighter-bombers, and artillery.

* "Briefing Paper" by Union of Concerned Scientists, 26 Church St., Cambridge, Mass. 02238.

Table 1

STRATEGIC NUCLEAR WEAPONS: AN OVERVIEW

	United States		Soviet Union	
	Delivery Systems	Warheads	Delivery Systems	Warheads
ICMBs	1,052	2,152	1,398	5,230
SLBMs	544	4,960	989	2,049
Bombers	316	2,228	150	300
TOTAL	1,912	9,340	2,537	7,579

Table 1a

LAND-BASED INTERCONTINENTAL BALLISTIC MISSILES (ICBMs)

	Year of First Deployment	Missiles	Warheads[a]	CEP[b] (meters)	Yield[c] (MT per Warhead)
United States					
Titan II	1962	52	52	1300	9.0
Minuteman II	1966	450	450	370	1,2
Minuteman III	1970	550	1650	220,280	0.17,0.34
SUB TOTAL		1052	2152		
Soviet Union					
SS-11	1966	570	570	1100, 1400	0.1-0.3, 1.0
SS-13	1968	60	60	2000	0.75
SS-17	1975	150	600	450	0.75,6.0
SS-18	1975	308	2500[d]	300,350 450	0.50,0.90, 20.0
SS-19	1975	310	1500[e]	300,500	0.55,5.0
SUB TOTAL		1398	5230		

180

NOTES

[a] Missiles in both arsenals are equipped with multiple, independently targetable re-entry vehicles (MIRVs) -- multiple warheads individually guided to strike separate targets.

[b] CEP is the radius of the circle around a target in which there is a 50 percent probability that a warhead aimed at that target will fall. CEPs for each weapon vary as indicated.

[c] Yield is the force of a nuclear explosion expressed as an equivalent of energy produced by tons of TNT. Yields for each weapon vary as indicated.

[d] Estimate based on the assumption that the bulk of SS-18s carry eight warheads per missile.

[e] Estimate based on the assumption that 75 percent of the SS-19s carry six warheads per missile, while 25 percent carry one warhead per missile.

STRATEGIC NUCLEAR WEAPONS

Intercontinental Ballistic Missiles (Table 1a)

Supporters of a U.S. strategic buildup frequently allude to Soviet ICMB "superiority." The Soviets have a large number of land-based missiles and warheads as well as greater throwweight, and they continue to modernize and expand their ICBM arsenal. But the U.S. also maintains a formidable ICBM force.

U.S. ICBMs are more accurate and reliable than their Soviet counterparts. In the last three years, 300 Minuteman III missiles have been equipped with 900 new war-warheads and sophisticated guidance systems that double their explosive yield and improve their accuracy. As ICBM accuracy increases, smaller warhead payloads can be used without sacrificing destructive capability. Thus, while Soviet ICBMs can deliver greater megatonnage, U.S. missiles can strike closer to hard targets, allowing use of less powerful warheads than those of the Soviets.

President Reagan has repeatedly spoken of the "window of vulnerability," contending that the Soviets are better equipped to destroy land-based ICBMs in their hardened silos. But the President assumes that Soviet missiles are more reliable and accurate than can be demonstrated. In fact, most arms experts agree that neither superpower's arsenal is sufficient to guarantee destruction of all the other's missile silos.

Reliability is also a critical factor: The U.S. Minuteman missiles are all solid-fuel rockets, while only the older Titan II -- now being phased out -- continues to use liquid fuel. But all Soviet ICBMs except the SS-13, of which there are only 60, use highly corrosive, volatile liquid fuel. As a result, more Soviet missiles are down for repair or maintenance at any given time than are American missiles.

Lastly, a recent Pentagon study found that the U.S. technology is superior to that of the Soviet Union in many areas critical to strategic defense, including missile guidance systems, computers, and radar. Even Secretary of Defense Caspar Weinberger has characterized our technological edge as "immense."

Table 1b

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBMs)

	Year of First Deployment	Missiles	Warheads[a]	CEP[b] (meters)	Yield[c] (MT per Warhead)
United States					
Poseidon C-3	1971	304	3040[a]	450	0.05
Trident C-4	1980	240	1920[a]	450	0.10
SUB TOTAL		544	4960		
Soviet Union					
SS-N-5	1964	57	57	2800	1.0
SS-N-6	1968	400	400	900,1400	0.2, 1.0
SS-N-8	1972	292	300	450, 900 1300	0.2, 0.3, 1.0
SS-NX-17	1977	12	12	1500	1.0
SS-N-18	1978	208	1040	600,1400	0.2, 0.45
SS-NX-20	1982	20	240	n.a.	n.a.
SUB TOTAL		989	2049		

NOTES

[a] May carry up to 14 warheads per missile.

[b] CEPs for each weapon vary as indicated.

[c] Yields for each weapon vary as indicated.

Submarine-Launched Ballistic Missiles (Table 1b)

The Reagan Administration contends that the Soviets are also gaining an edge on the U.S. in SLBM capability. In fact the U.S. has chosen to strengthen the SLBM component of the triad because it is the least vulnerable to Soviet attack. Secretary of the Navy John Lehman has said that U.S. missile-carrying submarines

are likely to become even less vulnerable through the year 2010.

The Soviet Union has deployed four new classes of SLBMs and over 60 new missile-carrying submarines in the past 15 years, while the U.S. built only two new types of submarine missiles and actually withdrew 10 submarines from strategic service during the same period. However, the two new missiles developed by the U.S. are superior to the Soviet SLBMs.

The U.S. Poseidon C-3 and Trident C-4 are both MIRVed missiles capable of carrying up to 14 warheads, more than can be carried by any single Soviet SLBM. Like the Soviet ICBMs, Soviet SLBMs can deliver greater megatonnage than U.S. submarine-launched missiles. But U.S. SLBMs are considerably more accurate than their Soviet counterparts. Moreover, all of the U.S. SLBMs are solid-fueled, while all Soviet SLBMs except the SS-NX-17 are of the less-reliable liquid-fueled variety.

Lastly, the U.S. keeps more than 50 percent of its submarines at sea at all times, where their detection beneath the ocean's surface is virtually impossible. Approximately 15 percent of Soviet submarines are at sea at any given time; the remainder are in port, where they are far more vulnerable to attack.

Table 1c

BOMBERS

	Year of First Deployment	Bombers	Warheads	Payload[a] (x 1000 lbs.)	Yield (MT per Warhead)
United States					
B-52s	1956	316	2228	60.0,70.0	0.2,1.0
SUB TOTAL		316	2228		
Soviet Union					
Bears	1956	105	210	40.0	1.0
Bisons	1956	45	90	20.0	1.0
SUB TOTAL		150	300		

[a] Payload for the B-52s varies as indicated.

Bombers (Table 1c)

Long-range bombers were the first means of delivering nuclear weapons to their targets. For more than two decades, both superpowers have placed far greater emphasis on the ICBM and SLBM legs of the nuclear triad. Nonetheless, Administration officials emphasize the need to supplement our B-52s, first deployed 25 years ago, with a new, long-range strategic bomber. President Reagan has also warned of a strategic "imbalance" precipitated by the construction of 200 new Soviet Backfire bombers.

It is misleading to call the Backfire a long-range strategic bomber: It is unable to fly intercontinental distances round trip without refueling, and the Soviets currently lack the capability to do so.

The U.S. has consistently upgraded the B-52 with sophisticated electronic countermeasures, such as radar-jamming devices. Moreover, 14 B-52s are being fitted with 12 "cruise" missiles each; up

to 200 B-52s will eventually carry the missiles. "Cruise" missiles are small, nuclear-tipped missiles with a range of about 1500 miles that can be launched from the ground, air, or sea. They give our strategic bomber force the capability for unmanned penetration deep into the Soviet Union.

Table 2

THEATER NUCLEAR WEAPONS IN EUROPE

Intermediate-Range Systems (200-3000 miles)[a]

Atlantic Alliance		Warsaw Pact	
Ground-Based Missiles		Ground-Based Missiles	
SSBS-3 (France)[b]	18	SS-20	243
Pershing 1 (U.S.,NATO)	180	SS-4/5	248
		SS-12/SS-22	170
		SS-1/SS-23	603
Sea-Based Missiles		Sea-Based Missiles	
Polaris A-3(Great Britain)	64	SS-N-5	39
MSBS M-20 (France)	80		
Bombers and Fighter-Bombers		Bombers and Fighter-Bombers	
Vulcan (Great Britain)	48	Backfires	100
F-111 (U.S.)	156	TU-16	310
F-4 (U.S.,NATO)	424	TU-22	125
F-104 (NATO)	290	SU-24 Fencer	550
F-16 (U.S.,NATO)	68	MIG-27 Flogger D	550
Jaguar (G.B., France)	117	SU-17 Fitter C/D	688
Mirage III-E (France)	30	SU-7 Fitter A	265
Buccaneer (Great Britain)	50	MIG-21 Fishbed J-N	100
A-7E (U.S.)	48		
A-6E (U.S.)	20		
Super Etendard (France)	16		
SUB TOTAL	1609		3991

Short-Range Systems (less than 200 miles)

Atlantic Alliance		Warsaw Pact	
Ground		Ground	
Lance (U.S.,NATO)	97	Frog 3/7/SS-21	697
Honest John (NATO)	90	Artillery	168
Pluton (France)	42		
Artillery (U.S.,NATO)	2137		
SUB TOTAL	2366		865
TOTAL	3975		4856

NOTES

[a] Some analysts prefer to divide this classification into two categories: long-range theater nuclear weapons, with ranges of more than 1000 miles and medium-range theater nuclear weapons, with ranges of 200-1000 miles. The two categories are merged under the heading "intermediate-range systems" in this primer because that is the way they are characterized in ongoing U.S.-Soviet arms talks.

[b] Countries that deploy weapons appear in parentheses after the weapons system. NATO is used to designate "two-key" weapons systems, in which the warheads are controlled by the U.S. and the delivery vehicles by other NATO nations.

THEATER NUCLEAR WEAPONS

Interpreting the Numbers (Tables 2-4)

While the number of delivery systems on each side can be reliabl estimated a true accounting of warheads is more difficult, in part because both U.S. and Soviet missiles can carry either nuclear or conventional weapons. It is estimated that NATO deploys about 6000 nuclear warheads, while the Warsaw Pact is thought to have 3500-6000 nuclear warheads for use in the European theater.

Several factors complicate assessments of this diverse

category of weapons. For example, strategic weapons in both arsenals could theoretically be retargeted on Europe, as is the case with the nearly 400 U.S. SLBMs under the direction of NATO's Supreme Allied Commander. This also holds true for the variable-range Soviet SS-11 and SS-19 ICBMs, as well as for the Soviet SS-N-6 SLBMs, stationed in the Baltic Sea and believed to be intended for the European theater.

Assessment is further complicated by the fact that the two theater arsenals are not symmetrical. The Soviets deploy a greater number of long- and medium-range theater systems, based in the Soviet Union and unable to reach Western Europe. NATO, on the other hand, deploys many more short-range weapons to counter what the alliance regards as Warsaw Pact superiority in conventional forces. These weapons could be used against Soviet tank formations.

The U.S. and the Soviets differ strongly over what weapons should be included in the totals for each side. The Intermediate-Range Nuclear Forces Talks in Geneva have met with little success since they began in November 1981. As Tables 3 and 4 indicate, there are five areas of disagreement: (1) inclusion of British, French, and West German forces in the totals; (2) inclusion of 180 short-range Pershing 1 missiles under U.S. and joint U.S./NATO control; (3) inclusion of Soviet SS-20 missiles that can be targeted on either Europe or the Far East; (4) inclusion of 1788 long- and medium-range Soviet fighter-bombers, the SU-17 Fitters, SU-24 Fencers, and MIG-27 Floggers; and (5) inclusion of 120 Soviet short-range missiles: the SS-12s and SS-22s.

The British are part of NATO, but they maintain independent control over their nuclear arsenal, part of which is reserved for retaliation against direct attacks on Great Britain. France, while not a NATO member, has pledged to use nuclear forces if Western Europe is attacked. But the French also maintain sole control over their nuclear forces. The U.S. thus considers both the British and French arsenals as "strategic," and does not count them in its theater tallies.

The U.S. does not count Pershing 1 missiles, because it considers them short-range weapons, and also because those based

in West Germany are so-called "two-key" weapons not wholly under U.S. control: both U.S. and NATO officers must concur before these weapons can be used. The Soviets strongly dispute these positions, arguing that all NATO forces should be included in the tallies and that Pershing launchers could be readily upgraded to increase missile range.

Soviet SS-20 deployment has also been a major area of contention. The SS-20 is a long-range theater ballistic missile that carries three warheads and is mounted on reloadable, mobile launchers. The U.S. State Department, in contrast with IISS data, counts 345 SS-20s and regards all as theater nuclear weapons. The Soviets contend that only a third of their SS-20s are solely intended for Europe. Another third are "swing" weapons which can strike targets in either Europe or the Far East, presumably China. The final third are targeted only on the Far East, out of range of European targets. The U.S., however, also counts those missiles because they can be moved, although only with considerable difficulty. The U.S. has cited the presence of the SS-20s as a major factor in its decision to deploy 464 ground-launched "cruise" missiles (GLCMs) and replace existing Pershing 1s in Western Europe with 108 Pershing 2s, beginning in December 1983.

The U.S. tally includes nearly 1800 Soviet fighter-bombers which the Soviets contend are not necessarily for use in Europe. And lastly, the U.S. counts Soviet SS-12 and SS-22 missiles, which the Soviets regard as short-range weapons.

Table 3

THEATER NUCLEAR ARMS: THE U.S. COUNT

United States		Soviet Union	
Missiles	0	SS-20 missiles	345
F-111 fighter-bombers	164	SS-4, SS-5 missiles	260
F-4 fighter-bombers	265	SS-12, SS-22 missiles	120
A-6, A-7 fighter bombers	68	SS-N-5 SLBMs	30
FB-111 fighter-bombers	63	TU-26 Backfire bombers	100
		TU-16 Badger, TU-22 Blinder bombers	435
		SU-17, SU-24, MIG-27 fighter-bombers	1788
TOTAL	560		3078

Table 4

THEATER NUCLEAR ARMS: THE SOVIET COUNT

United States		Soviet Union	
Pershing 1 missiles	108	SS-20s, SS-5s, SS-4s	496
F111s, F-4s, A-6s, A-7s, FB-111s	555	SSN-5s	18
Great Britain		Backfires, Badgers, Blinders	461
Polaris missiles	64		
Vulcan bombers	56		
France			
Land-based missiles	18		
SLBMs	80		
Mirage-4 bombers	33		
West Germany			
Pershing 1 missiles	72		
TOTAL	986		975

SOURCE:
New York Times, 12/12/82. Times sources for U.S. count: IISS and U.S. State Department. For Soviet count: the late Soviet President Leonid I. Brezhnev and a paper by Lieut. Gen. Nikolai Chervov of the Soviet Union.

The Union Of Concerned Scientists

The Union of Concerned Scientists is a Cambridge, Massachusetts based, non-profit organization of scientists, engineers and other professionals concerned about the impact of advanced technology on society. UCS was established as an informal faculty group in the Boston area in 1969. It now has over 100,000 citizen sponsors nationwide.

APPENDIX D

POSSIBLE AREAS FOR ERRORS IN WEAPON TECHNOLOGY
(Examples Provided by Content of Technical Conference)*

- Review of Electromagnetic Wave Propagation and Analog Digital Modulation
- Effectiveness of Various Types of Jamming against amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), and frequency shift keying (FSK) systems
- Summary of Error Correcting Codes -- capabilities, limitations, and trade-offs
- Spread Spectrum Systems for LPI and AJ
  - Direct sequence (DS) -- basic principles, pseudo-noise (PN) sequences, concealment of PN waveforms, error probabilities, and acquisition techniques
  - Frequency hopping (FH) -- fast vs. slow hop, error coding with and without interleaving, bit and word error probabilities, and partial-band and repeater jamming
  - Hybrid DS/FH systems
  - Comparison of DS and FH performance
- Intercept Systems
  - Elementary detection theory -- ideal case, probabilities of detection and false alarm
  - Detection by radiometer and cross-correlator
  - Frequency estimation -- channelized, scanning superhetrodyne, and other receiver structures
- Adaptive Antenna Systems
  - Basic principles of noise correlation, adaptive beam forming, null steering
  - Application of general theory to sidelobe canceller
- Cryptography
  - Codes and ciphers
  - Basic ciphers for communication -- block and stream ciphers
  - An unclassified example: data encryption standard
  - Comparison of linear and nonlinear shift-register generators
  - Cipher-induced problems: errors, degraded synchronization, and anti-jamming
- Microwave Transmission Systems
  - System types and capabilities

Microwave Transmission Systems Cont'd.
- Baseband and IF repeaters
- Radio propagation (path clearance, fading, absorption)
- Interference and noise
- Pre-emphasis
- Frequency allocations

Satellite Transmission
- Satellite orbits
- Satellite transponder design parameters
- Satellite on-board power sources and processing
- Earth terminals (digital, analog)
- System power budgets
- Multiple access (FDMA, TDMA, CDMA)
- Demand assignment (SCPC, DAMA, SPADE)
- Major operational communications satellite systems
- Techniques for efficient spectrum use
- Future trends
- Orbital antenna farm
- Direct broadcast satellites

Digital Communications and Computer Network Systems

Introduction
- Categories of telecommunications
- Communications system design concept
- Functional communications block diagram
- Elements of network design
  - Traffic
  - Control
  - Classification
- Network architecture
  - Protocol hierarchies
  - ISO reference model

Network Topology
- Connectivity analysis
  - Backbone
  - Local access
- Grade of service
  - Blocking probability
  - Delay analysis
    - Queuing theory principles
    - Holding time

- Communications Principles
  - Bandwidth limited signals
  - Maximum channel rate
  - Network communications configurations
    - Network signaling
      - Common channel (separate)
      - In-band (embedded)
    - Multiplexing techniques
    - Multiple access techniques
    - Switching techniques
      - Circuit
      - Packet/message
  - Error control concepts
    - Error detection
    - Error correction
      - Linear algebraic coding
      - Convolutional coding
- Network Structure
  - Protocol structure
  - Elementary protocol
    - Simplex
    - Stop and wait
    - Sliding window
- Node-to-Node Networks
  - Point-to-point service
  - Routing algorithms
  - Congestion strategies
- Packet Networks
  - ALOHA approaches
    - Pure, slotted
  - Delay, throughput, stability concepts
- Local Access Networks
  - Carrier sense
  - Ring
- Transport/Session Layer
  - Addressing and connection establishment
  - Gateways
- CCITT Network Standards
  - X.21, X.25, X.75

Message Modifications
  Security
    Cryptographic structures
    Pseudonoise coding
  Compression/expansion
    Huffman coding
    Voice coding techniques
    Video coding techniques
Network Communications Examples
  Packet net
  Local access net
  Radio net
  Satellite net

Electronic Counter Measures (ECM)

Security Aspects
ECM Definitions, Equations, and Analysis
  Basic concept
  Radar/ECM equations
    Standoff, standforward, and escort jamming
    Missile guidance jamming
    Uplink and downlink jamming
ECM Transmitter Power, Antenna Gain, and Coverage
  Concepts, types, retro-reflectivity, antenna system beaconing
Current Active ECM System Signal Processing Techniques
  Application of traveling wave tubes to ECM
    Serrodyning concept
    Frequency memory
    Lookthrough
    Output signal association
    Pseudorandom sequencing
Active ECM System Technology -- State of the Art
  Noise jammers
    Blinking
    Cooperative jamming-multiaircraft
    Standoff, standforward, escort jamming
  Repeater jammers
    Concept
    AGC deception
    Cross eye

Repeater jammers Cont'd.
- False target generators
- Inverse gain
- Cross-polarization
- Multitarget blinking
- Monopulse radar jamming
- Delta and skirt jamming
- Velocity-gate walkoff
- Range-gate walkoff
- Angle-gate walkoff
- Force enhancement

Combination noise and repeater jammers
- Missile guidance jamming
- Cover pulse deception
- Noise and repeater block diagrams

Expendable jammers

Remotely piloted vehicle ECM

Passive ECM Technology
- Chaff, passive decoys

Reduction or Variation of Radar Observation of Targets
- Radar-absorbent material
- Aircraft RCS size-reduction methods
- Refraction
- The electronic support measures concept

ECM/ECCM Considerations and Conclusion

Military Communication Systems

Lightning Protection
- Characteristics of lightning
- Protective measures
- Lightning protection systems
- AC protective ground systems
  - Definition of shock levels
  - AC system requirements
  - AC safety protective measures

Signal Ground Systems
- Equipotential plane
- Lower and higher frequency systems
- Signal grounding techniques

Shielding and Interference Reduction
  Interference problems
  Shielding techniques
  Interference reduction techniques
Transient Protection
  Transient characteristics
  Transient protection devices
  Incorporation of transient protection devices
Overall Grounding System
  Summary of all grounding and bonding techniques
  Summary of requirements for communications/electronics facilities

Telecommunication Systems

Information Modulation
  Concepts
  Amplitude modulation
  Frequency modulation
  Phase shift modulation
  Single sideband modulation
  Digital formats
    OOK, ASK, FSK, PSK, MSK
  Pulse modulation
    PAM, PDM, PPM, PCM
  Design techniques
Information Demodulation
  Demodulation in noise and jamming
  AM: coherent and noncoherent
  FM: discriminators and phase-lock loops
  SSB demodulation
  Digital signal demodulation
    Costas loops, squaring loops
    Decision-directed demods
    Bit synchronization
    PAM, PDM, PPM, PCM
  Digital signal processing
  Design techniques and trade-offs
The Signal Path
  Threshold levels in demodulation
  Characteristics of the noise environment
  Interference and jamming

The Signal Path Cont'd.
- Effects of distortion
  - Amplitude distortion
  - Phase distortion
- Filters, amplifiers, and limiters
- Adjacent channel signals
- Signal-to-noise ratio
- Carrier-to-noise-density ratio
- Energy-per-bit-to-noise-density ratio
- Propagation characteristics

Correcting Signaling Errors
- Error rates
- Forward error correction
- Automatic repeat request
- Phase and amplitude correction
- Matched filters
- Adaptive interference rejection
- Spectrum spreading and contracting

* From program schedules of Optical Society of America, Laser Institute of America, 1983.

E00

APPENDIX E

GLOSSARY*

ABM--Antiballistic Missile System. The interceptor missiles, radars, and associated equipment of a system designed to intercept and destroy enemy ballistic missiles.

Attack Submarine--A submarine designed to destroy enemy naval vessels and merchant shipping.

B-1--A new U.S. supersonic bomber.

B-1B--A version of the B-1 bomber designed as a cruise missile carrier.

B-52--A current U.S. strategic bomber.

Ballistic Missile--A rocket-powered missile that, after being boosted to speed, coasts through a ballistic arc.

Broken Arrow--The U.S. Department of Defense code name for an accident involving nuclear weapons.

C^3I--Command, Control, Communication and Intelligence.

CIA--Central Intelligence Agency of the U.S. government.

Cosmos (Kosmos)--A series of Soviet satellites of which about seventy percent perform military missions.

Cruise Missiles--A guided missile using an "air breathing" engine and supported by the atmosphere. It flies like an airplane.

Deterrence--A nuclear strategy whereby a potential agressor is "deterred" from attacking because of the massive and unacceptable retaliation that will follow.

DoD--U.S. Department of Defense

Euromissiles--Refers to deployment of U.S. Pershing 2 and cruise missiles in Europe.

EMP--Electromagnetic pulse is an intense burst of electromagnetic energy created by a nuclear explosion that travels at the speed of light.

First Strike--The first offensive move of a war. The term is frequently used to refer to a major nuclear attack on enemy nuclear forces such as ICBM silos, bomber bases, etc. Also called preemptive strike.

Fission--A nuclear reaction where heavy atoms (such as uranium or plutonium) divide to form smaller atoms of about half the weight (An A-bomb explosion).

Fratricide--The destructive effect, from debris, EMP, etc. of a nuclear explosion on subsequent incoming warheads.

Fusion--A nuclear reaction where light atoms fuse together to form heavier atoms (a H-bomb explosion).

GAO--General Accounting Office. A congressional watchdog on financial expenditures.

GLCM--Ground-Launched Cruise Missile. A cruise missile launched from ground installations or vehicles.

Ground Zero--The point on the earth's surface at which a nuclear weapon is detonated.

IAEA--International Atomic Energy Agency. The agency that monitors activities at nuclear power plants and other nuclear-related activities to help inhibit the proliferation of nuclear weapons.

ICBM--InterContinental Ballistic Missile.

Kiloton--The nuclear explosive force equal to one-thousand tons of conventional high explosives.

Launch on Warning--The policy or strategy of launching ICBMs on the basis of information supplied by satellite and other warning systems which indicate that an enemy missile attack is coming.

Looking Glass--Code name for the Strategic Air Command's airborne command posts.

Mach--Mach numbers are used to denote speed of rockets and aircraft relative to the speed of sound. M-1 is about 750 miles per hours.

MAD--Mutual Assured Destruction.

Megaton--The nuclear explosive force equal to one-million tons of conventional high explosives.

MIRV--Multiple Individually-targeted Reentry Vehicle.

MX--Missile-X. A new intercontinental ballistic missile being planned by the U.S.

MRV--Multiple Reentry Vehicle (not independently targeted).

NATO--North Atlantic Treaty Organization.

NAVSTAR--The U.S. global positioning system of satellites being developed.

NCA--National Command Authority of the U.S.

NORAD--North American Aerospace Defense Command.

PAVE PAWS--New phased-array radars for detecting submarine-launched ballistic missiles.

RADAR--Radio Detection and Ranging.

SALT--Strategic Arms Limitation Talks.

SLBM--Submarine-Launched Ballistic Missile.

SLCM--Sea-Launched Cruise Missile.

SS-20--A Soviet intermediate-range ballistic missile being deployed against Western Europe.

START--Strategic Arms Reduction Talks.

Stealth--An aircraft or cruise missile using new technologies to make it less visible to radar.

Strategic--Having to do with strategy: the planning and directing of large scale military operations as distinguished from tactical. In the case of nuclear weapons this is global in scope.

Tactical Nuclear Weapons--Nuclear Weapons designed to be used in a theatre of operations. They are shorter range than strategic nuclear weapons.

Tomahawk--Name for the General Dynamics cruise missile.

Trajectory--The ballistic arc through which a ballistic missile travels

Trident--The new sea leg of the U.S. strategic triad. The new submarine is called Trident. The first and second generation missiles are called Trident-1 and Trident-2 respectively.

Typhoon--A new Soviet ballistic missile submarine which will probably carry twenty SS-NX-20 SLBMs.

Wimnex--Jargon pronunciation for the World Wide Military Command and Control System (WWMCCS).

Yankee--A class of Soviet nuclear-powered ballistic missiles submarine which carries sixteen SS-N-6 SLBMs each.

*We have tried to make this complex subject as widely understandable as possible. It is necessary to use some specialized terms and they are defined here. An extensive and very useful glossary of modern weapons' acronyms and terms is available in Robert Aldridge's book, *First Strike*, South End Press, Boston MA 1983.

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